PERIODICAL ROOM
GENERAL LIBRARY
UNIV. OF MICH.

Vol. XXXII, No. 7 *Whole No. 279*

OCTOBER, 1932

SCHOOL SCIENCE AND MATHEMATICS

FOUNDED BY C. E. LINEBARGER

A Journal for all SCIENCE AND MATHEMATICS TEACHERS

CONTENTS:

Life of the Past

The Glass of Fashion

An English Christmas Tree

Retrogression of the Planets

The Junior Academy of Science

Mathematics in the Sheet Metal Work

Published by THE CENTRAL ASSOCIATION OF SCIENCE AND MATHEMATICS TEACHERS
Publication Office: 450 AHNAIP ST., MENASHA, WISCONSIN
Business Manager: 3319 NORTH FOURTEENTH ST., MILWAUKEE, WISCONSIN
Editorial Office: 7633 CALUMET AVENUE, CHICAGO, ILLINOIS

Published Monthly, October to June, Inclusive, at Menasha, Wisconsin. Price $2.50 per year: 35 cents per copy. Entered as second class matter March 1, 1913, at Mount Morris, Illinois, under the Act of March 3, 1879. Application has been made for transfer of second class entry to Menasha, Wisconsin.

TURTOX NEWS

Free to Biology Teachers

Turtox News is published monthly by the General Biological Supply House and is mailed without charge to Biology teachers in High Schools and Colleges of the United States and other countries. Recent issues have contained the following articles in addition to announcements of new developments for the Biology laboratory:

Practical Suggestions for Embryological Technique.
The Use of Lantern Slides in Teaching Biology.
Notes on the Collecting and Preserving of Some of the More Common Mosses.
Earth An Album of Pressed Forests.

TURTOX PRODUCTS

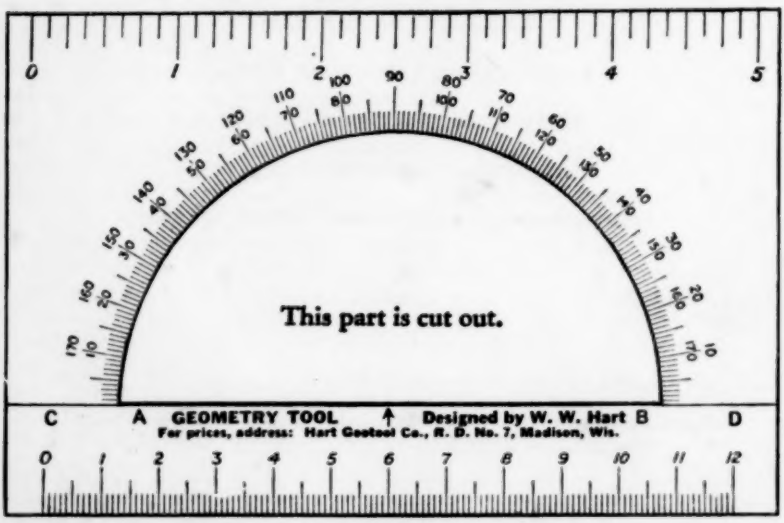
The Sign of the Turtox Pledges Absolute Satisfaction

If you are not now receiving Turtox News ask to have your name placed on our mailing list. Please be sure to give us your teaching address.

GENERAL BIOLOGICAL SUPPLY HOUSE
Incorporated
761-763 East Sixty-ninth Place
CHICAGO

HARTS GEOTOOL

Straightedge—English-Metric Scale—Square—Protractor
(Three-quarter size facsimile.)



Made of heavy, durable, gray pressboard.

Retails at 5c. Discounts quoted on quantities sold to schools or dealers. For free sample, send self-addressed envelope to Hart Geotool Company, R.D. 6, Madison, Wis. ***No other tool meets the same needs at as low cost.***

SCHOOL SCIENCE AND MATHEMATICS

VOL. XXXII, No. 7 OCTOBER, 1932 WHOLE No. 279

THE CENTRAL ASSOCIATION OF SCIENCE AND MATHEMATICS TEACHERS OF 1932

The Cleveland Convention of the Central Association of Science and Mathematics Teachers to be held on November 25 and 26 is stirring interest far and wide among the teachers of the Middle West. Professional spirit and co-operation is far stronger than in any of the years of prosperity. Teachers from all sections are demanding a strong, highly professional organization—a powerful Central Association that will not only increase the effectiveness of the members as teachers but one that will be a bulwark of strength in aiding the profession in this trying period.

The active interest which teachers are showing in the Thanksgiving Meeting of the Association in Cleveland is such that a record breaking attendance is promised. A new fighting spirit is in the air. Everyone seems to have realized, all at once, that the price of progress and security is in a virile, all powerful organization, to which every science and mathematics teacher in the Middle West is a member and to which each teacher gives his allegiance and support.

The fact that the Central Association of Science and Mathematics Teachers has served to stimulate and inspire teachers in these respective departments for over thirty years is a tribute to the progressive spirit of the Central West. Those of us who are just beginning owe a debt of gratitude to the educational leaders in those respective fields who have directed the destinies of this outstanding institution through the years and endowed the Association not only with the fruits of their services but with their eternal spirits as well.

We who have been attracted to this association by these magnetic forces feel that the annual programs have always listed the names of the foremost mathematicians and scientists; that the hundreds of projects initiated and carried to successful completion by the best and most progressive teachers in these fields in America make it stand out as a fountain of inspiration; and that the official journal, SCHOOL SCIENCE AND MATHEMATICS, the only journal of its kind in existence and which reaches to the ends of the earth, occupies a unique place in the field of educational journalism. Many science and mathematics teachers owe their professional awakening with a consequent rise in position and salary to the stimulus of this association and its Journal.

The Convention Committee is very happy to announce to the members of the Association that the national leaders in educational thought who will appear on the program of the approaching convention in Cleveland are as follows:

1. Dr. Wm. E. Wickenden, President, Case School of Applied Science.
2. Mr. Chas. H. Lake, First Assistant Superintendent, Cleveland Public Schools.
3. Dr. Otis Caldwell, Teachers College, Columbia University.
4. Dr. L. C. Karpinski, Professor of Mathematics, University of Michigan.
5. Dr. David Dietz, Scripps Howard Science Editor and Scientist.
6. Dr. George W. Crile, one of the Founders and Present Director of the Cleveland Clinic.
7. Hon. Newton D. Baker, the great "Human Scientist" has assured the Committee he will appear on our program (no preventing providence).

The sectional programs which appear on pages 709-710 list the names of many nationally known men. The Association is especially fortunate in being able to secure the services of these men and is deeply indebted to the sectional officers and the Convention Committee for their accomplishments.

Every science and mathematics teacher should mark the date November 25 and 26, 1932, and plan to be in attendance. You just cannot afford to miss this program. As a progressive

teacher you well realize the permanent values accruing in your professional growth from the contacts with the leaders from other places. To those of you who have never attended this annual Thanksgiving Conference believe us you certainly have a worth-while surprise in store for you.

For information regarding special coaches and excursion rates to Cleveland, call your State Marshal—

for INDIANA: Mr. Walter Gingery, Prin., Washington High School, Indianapolis

for ILLINOIS: Mr. Glen W. Warner, 7633 Calumet Avenue, Chicago

for ILLINOIS: Dr. Chas. Stone, University of Chicago

for WISCONSIN: Mr. Ira Davis, University High School, Madison

for MICHIGAN: Mr. C. L. Thiele, Board of Education, Detroit

for OHIO: Mr. Louis E. Welton, Assistant Prin., John Hay High, Cleveland

for OHIO: Mr. Chas. Marple, 6801 Euclid Avenue, Cleveland

BEACON LIGHTS OF CLEVELAND CONVENTION

GEORGE WASHINGTON CRILE

SUBJECT: THE RÔLE OF PHYSICS AND CHEMISTRY IN LIVING ORGANISMS

The famous surgeon, Dr. Crile, one of the speakers before the Physics Section at the November, 1932, meeting of the Central Association of the Science and Mathematics Teachers was Professor of Surgery at Western Reserve University School of Medicine, lecturer and demonstrator of histology 1889-1890, Professor of Physiology 1890-1893, Professor Principles and Practice of Surgery 1893-1900, University of Wooster—now Western Reserve University; Professor of Clinical Surgery 1900-1911 and Surgery 1911-1924, Western Reserve University; Visiting Surgeon Lakeside Hospital 1911-1924.

He was one of the founders of the justly celebrated Cleveland Clinic Foundation February, 1921, whose present plant rivals the famous Mayo plant at Rochester, Minnesota. The Cleveland Clinic now occupies the most extensive and complete hospital research laboratory and consultation rooms in the city of Cleveland, between 90 and 93 Streets and Euclid and Carnegie.

Perhaps Dr. Crile's greatest contribution to suffering mankind is his shockless operation by means of which the one operated on suffers none of the ill effects of nausea and sickness so long the dread of patients who had undergone operations.

Dr. Crile was the recipient March 28, 1925, of the Lannelongue Prize founded by Monsieur Lannelongue, which consists of the award of a gold medal every five years together with a gift of 5000 francs. Dr. Crile was the third recipient of the award—the first in 1915, Sir Victor Horsley, an Englishman, and the second in 1920 a Frenchman, Monsieur M. Henri Gaudier.

In 1914 Dr. Crile was awarded the gold medal by the American Medical Society for advances made in methods of the use of anesthetics which eliminated shock in surgical operations.

He was awarded the D.S.M. by Congress in 1919 and presented the same by General Pershing; honorary member Division 3 Class Companion of the Bath by the British in 1919 and a Chevalier of the Legion of Honor by the French in 1922.

This is a brief résumé of some of the outstanding achievements in Dr. Crile's busy life. For a fuller account the reader is referred to the 1932 "Who's Who in America."

OTIS W. CALDWELL

SUBJECT: SCIENCE—TRUTH OR PROPAGANDA?

Dr. Caldwell went to Teachers College of Columbia in 1917 as professor of Education and director of the Lincoln Experimental School. During the time that the Lincoln School was being organized and established he was instrumental in securing its present building which cost one and one-half millions of dollars, and in addition a three million dollar endowment for the school. At the present time Dr. Caldwell, as director of the Institute of School Experimentation, and his staff, are carrying on research in a building which was built by funds contributed by families whose children attended the Lincoln School. Dr. Caldwell has on three different occasions studied Science teaching conditions and methods in Europe, and has twice visited parts of Asia for the same purpose. He is chairman of the A.A.A.S. committee on the place of Science in education, and chairman of the Central Association committee on A Four Year Science Course. His other activities include: trustee American Foundation for the Blind, chairman of the Survey Commission and member of the conservation committee of the Near East Foundation, member of the educational committee of the National Parks Association, Phi Delta Kappa, Sigma Xi, and various other national scientific and educational organizations. Dr. Caldwell has published many books and articles which include: Laboratory and Field Manual of Botany, Plant Morphology, Introduction to Botany, Practical Botany, Elements of General Science, Laboratory Manual of General Science, Science Remaking the World, Then and Now in Education, Open Doors to Science, Introduction to Science, and Biological Foundations of Education.

DR. WILLIAM E. WICKENDEN

From 1923 to 1929 William E. Wickenden was the Director of Investigation of the Society for Promotion of Engineering Education. His job was "to study the process by which the curriculum of 50 years ago has come to its present form; to set forth the nature and weakness of the present curriculum and indicate such modifications as seemed desirable."

The result of this investigation was so significant that Dr. Wickenden became President of Case School of Applied Science in 1929. Prior to the inquiry into Engineering Education, he had been an instructor at the University of Wisconsin, an assistant and then associate professor of elec-

trical engineering at the Massachusetts Institute of Technology. As Personnel Manager of the Western Electric Company and as Assistant Vice President of the American Telegraph Company he worked with engineering schools throughout the country to make the training given in the engineering schools meet the demands of industry more adequately.

An outstanding leader in charting the course of Engineering Education, Dr. Wickenden is a charming speaker, a graceful story teller and the committee is especially fortunate in securing him to deliver the keynote address.

FRANCIS D. CURTIS

SOME IMPLICATIONS OF RECENT RESEARCH IN GENERAL SCIENCE

A recognized leader in the field of research in General Science, Francis D. Curtis is thoroughly qualified to discuss the implications of recent research in this branch of Science teaching. After several years as a successful teacher of high school Science, Dr. Curtis received the Ph.D. degree in Science Education from Columbia in 1924. He is a department editor of *Science Education*, and has been elected to membership in the following: National Council of Education, Educational Research Association, Society of College Teachers of Education, Society for the Study of Education, College Specialists in Curriculum Making, American Association for the Advancement of Science, National Association for Research in Science Teaching, and the Science Masters Association of Great Britain. Dr. Curtis is now associate professor of The Teaching of Science and Secondary Education at the University of Michigan.

Respectfully submitted,

JAMES C. ADELL, *Chairman Publicity Committee.*
CHARLES MARPLE, *State Marshal for Ohio.*
CLARENCE NEAL, *Secretary General Science Section.*
F. R. BEMISDERFER, *President.*

THE SECTION PROGRAMS OF THE C.A.S. AND M.T.

GENERAL SCIENCE SECTION

"Public Interest in General Science." David Dietz, Scripps Howard Science Editor.

"Results of Recent Research in General Science." Francis D. Curtis, University of Michigan High School.

"Some Demonstration Techniques in General Science." Morris Meister, New York University.

"Cleveland's Research Program in General Science." William L. Connor. Director of Research, Cleveland Public Schools.

CHEMISTRY SECTION

"Colloids." Dr. Harry Holmes, Oberlin College, Oberlin, Ohio.

"Pandemic Chemistry in High School." G. T. Franklin, Lane Technical High School, Chicago, Ill.

"The Rôle of Chemistry and Physics in the Living Organisms." (Probably), Dr. Geo. W. Crile, Cleveland Clinic, Cleveland, Ohio.

BIOLOGY SECTION

"The Beginning of Circulation in the Chick Embryo." A Micromovie showing the most interesting stages in the development of the heart-beat and establishment of circulation. By Dr. Bradley M. Patten, Baldwin Bird

Research Laboratory, and Associate Professor of Histology and Embryology, School of Medicine, Western Reserve University.

"A Critical Evaluation of Biology Work Books." Ellis C. Persing, Assistant Professor of Elementary Science, School of Education, Western Reserve University.

DISCUSSION: Mrs. Orra Olive Dunham, Collinwood High School.

"The Junior Academy of Science." Dr. C. G. Shatzer, Dean of Wittenberg College, Springfield, Ohio.

DISCUSSION: Mr. E. G. Pierce, East Technical High School, Cleveland.

"Test in Biology." Dr. Ralph Tyler, Bureau Education Research, Ohio State University.

DISCUSSION: Mr. Lewis Mills, Glenville High School, Cleveland.

"Biology Stations in Europe." Dr. J. Paul Visscher, Professor of Biology, Adelbert College, Western Reserve University.

MATHEMATICS SECTION

"The Unit Plan in Plane Geometry and Measuring its Results." Miss Edith Sechrist, East Technical High School, Cleveland, Ohio.

"Linear and Quadratic Equations in Geometry." Professor Louis C. Karpinski, University of Michigan, Ann Arbor, Mich.

"Economy of Effort in Teaching." Mr. Joseph A. Nyberg, Hyde Park High School, Chicago, Ill.

GENERAL DISCUSSION.

GEOGRAPHY SECTION

"The Value of Aerial Photographs in Teaching Geography" (illustrated). Major Clyde H. Butler, Aerial Surveys Inc., Cleveland, Ohio.

"New Phases of Weather Observation in Connection With Air Transportation" (illustrated). Ralph Wensinger, Official Weather Observer, Cleveland Airport.

PHYSICS SECTION

"Radio in High School." Mr. G. B. Hamman, East Technical High School, Cleveland, Ohio.

"The Rôle of Chemistry and Physics in the Living Organism." Dr. George Crile, Cleveland Clinic, Cleveland, Ohio.

"Some Interesting Apparatus from England and Germany." Dr. N. Henry Black, Harvard University.

PROPOSED AMENDMENT TO THE BY-LAWS OF THE C.A.S. AND M.T.

Article V, Section 4. Insert the words "Elementary Science" following the word "Chemistry." This Section will then read as follows:

Section 4. Professional Sections: The association shall be divided into sections as follows: Biology, Chemistry, Elementary Science, General Science, Geography, Mathematics, and Physics. Each section shall be composed of members of the Association who are especially interested in the subject of that section. The organization and activities of the sections may be amended from time to time by the Board of Directors. Unless otherwise provided by the Board of Directors, each section shall elect its own Chairman, Vice-Chairman and Secretary.

LIFE OF THE PAST—A UNIT FOR A COURSE OF STUDY IN HIGH SCHOOL BIOLOGY

By Mildred Pickle Mayhall, *Instructor in Anthropology*
University of Texas
and
W. W. McSpadden, *Supervisor of Sciences, Austin, Texas*
Public Schools

The authors have for some years introduced into their course of study in High School Biology some paleontologic study. Reference to such material is seldom found in most biology textbooks, due largely to the rigid lines of demarkation of the subject matter. Most courses of study do not incorporate such material due more largely to the lack of time for covering more than the essentials of biology within the school term rather than to a lack of interest in paleontologic studies relative to biology. It is true that paleontology is a science unto itself and is not a subject within the high school curriculum. However as we know more and more of past life through recent discoveries, the public mind finds many interesting problems for speculation, and even the boy or girl of high school age, who possesses some native curiosity, arrives at wonder, speculation, and inquiry. Enquiring minds deserve some attention in the answering of questions.

Adolescent students find a new avenue for adventure with the introduction of some study of past life into the course of high school biology. Biology, the science of life, of present day types of plants and animals, becomes much more meaningful when it relates present forms with those of the past. More significance is attached to adaptations, change, natural selection, heredity, etc., when present forms of life are allied with ancestral types and origins made clear. The biology teacher who knows something of past life can enrich, broaden, and enliven his discussions in biology, as well as supply much knowledge of a thorough scientific character to the minds of his pupils.

Besides adding novelty and fascination to the course, the study of archaic forms of life gives the student some conception of the great age of the earth, of scientific time reckoning, of climatic change, of adaptation to environment, and of the progressive development of life. Such studies, however

brief, have great value. They lead to an appreciation of life history and to the rôle played by animals, particularly mammals and man, in the past and in the present. Such studies also lead to an early appreciation of and an interest in museum exhibitions, and through such interest encourage the preservation of valuable museum material and discourage the needless waste of present wild forms of life. Needless to say, a great deal of our teaching today is done in and through the use of museums, especially in the large cities.

In addition to furnishing knowledge and entertainment, paleontologic material in high school biology gives the student a background for evaluating theories in modern science and encourages an appreciation of the broad scientific principles of biology that goes far toward removing unjust prejudices for scientific study and a use of science in modern life. Following is an outline of the unit:

LIFE OF THE PAST

I. The formation of fossils (Lucas 1-10; Miller 3-6; Kinsey 210-213; 220-225.)
   A. Definition of fossils
      1. Conditions suitable for fossilization
      2. Age of fossils
      3. Types of fossils
II. Chronology (Roy 1-11; Kinsey 217-220.)
   A. Divisions of earth history
   B. The geological time table (Roy 11; Noe 127.)
III. Predominant life of the ages (Lull 115-116; Heal 109-112.)
   A. First evidences of life—Archeozoic and Proterozoic Eras (Miller 46, 53.)
   B. Life of the Paleozoic Era (Lull 118-137.)
      1. Plant life (Miller 71, 91, 113, 132, 153, 169, 190; Transeau 495-500; Noe 50-78.)
         a. Importance in coal deposition (Miller 169; Kinsey 214).
      2. Animal life (Miller 71, 91, 113, 133, 154, 172, 190; Lucas 11-21).
         a. Invertebrates
         b. Vertebrates
   C. Life of the Mesozoic Era (Lull 138-175; Kinsey 215-217.)
      1. Reptilian dominancy (Miller 215, 233, 263-273.)
         a. Rulers of the ancient seas (Lucas 32-49.)
            (1) Types
               (a) Icthyosaurs
               (b) Plesiosaurs
               (c) Zeuglodon
         b. Dinosaurs, the land reptiles (Lucas 80-95.)
            (1) Types (Lucas 3-20, Hall of Dinosaurs, A.M.N.H., no. 70.)

(a) Brontosaurus
(b) Triceratops
(c) Stegosaurus
(d) Tyrannosaurus
(2) Adaptation—food habits, size, brain, etc.
c. Pterodactyls, the flying reptiles (Lucas 69-79.)
(1) Types
(a) Pteranodon
(b) Dimorphodon
(2) Manner of flight
2. Other forms of life
a. Earliest known birds (Lucas 50-67.)
(1) Types
(a) Archaeopteryx
(b) Hesperornis
(c) Ichthyornis
b. Sucking insects and flowering plants (McCabe 71-81; Transeau 500-502; Noe 116-126.)
c. Early mammals (Miller 235, 263; Lull 178, 184.)
3. The passing of the great reptiles
a. Causes of extinction (Lucas 175-186.)
(1) Overspecialization
(2) Climatic changes
(3) New life, i.e., encroachment of mammals

D. Life of the Cenozoic
1. Types of plant and animal life (Miller 311-327; 369-381; Lucas 115-129; Noe 79-88; Transeau 502.)
2. Conditions favorable to the rise of mammals (Lull 176, 177.)
3. Types of mammalian life (Miller 318; Lull 184-201; Lucas—Guide Leaflet 57.)
a. Monotremes
b. Marsupials
c. Placental mammals
4. Examples of mammalian life
a. Development of the horse (Lucas 131-143; Lull 201-206; Matthew and Chubb—Guide Leaflet 36.)
b. Development of the elephants (Lucas 145-157; 159-173; Lull 209-213; Osborn—Guide Leaflet 62.)
c. Primate forms (Miller 327.)
5. The great Ice Ages (Miller 328-365; McCabe 48-58.)

E. The rise of man (Lull 263-296; McCabe 105-116.)
1. Early man
a. Types
b. Life and conditions of development (Kiner 11-110.)

In the foregoing outline, references to Lucas, refer to "Animals of the Past" unless the title is given. All references used in this outline will be found listed in the bibliography at the end of this article.

SUMMARY OF THE OUTLINE

Fossils are the remains of plants and animals buried in the earth's crust. Fossils include, in addition to the actual remains

of life, indications of past life such as footprints, worm tracks, etc., that have been preserved. To be classed as a fossil, it is not necessary for a specimen to show replacement of living matter by mineral matter, although petrifaction is a common type of fossilization. Paleontology is the "science of ancient life."

Fossils are commonly found in sedimentary deposits, sometimes in metamorphosed formations but almost never in igneous formations. Sedimentary deposits are those that are deposited in layers or strata and include limestone, sandstone, shale, etc. The conditions under which stratified rocks are deposited are ideal for preserving the remains of plants and animals. The largest number of fossils, especially of invertebrate animals, are preserved in shore and sea deposits, the shells and hard parts settling into soft mud, sand, and lime deposits. These harden into rock and with elevation are then exposed to erosion. Preservation of land animals is less frequent, since the hard parts must be preserved from decay by being covered with water or buried in soil away from the action of the air. Some lake, marsh, and asphalt deposits give us good records of past life, and particularly peat-bogs. Wind-blown deposits such as dune-sand and loess often contain fossils.

Types of fossils include (1) preservation of the entire organism by freezing. This is rare but is exemplified by species of mammoths and rhinoceroses found in frozen soil in Siberia. (2) Preservation of the entire organism by natural embalmment is shown by the insects preserved in amber of the Baltic Sea region. (3) Preservation of the hard parts of the organism is a common kind of fossilization, where the bones, shells, etc., have been preserved. (4) Preservation of carbon only is exemplified by many plants of the great Coal Age. The original structure is shown by the remaining carbon content. (5) Preservation of original form by casts and molds shows the form or shape of the fossil but the original material has been lost. (6) Preservation of original form and structure is called petrifaction. This is a common form of fossilization. The original animal or vegetable matter has been replaced by mineral matter such as silica or carbonate of lime. (7) Preservation of tracks of animals may be exemplified by tracks of great extinct reptiles. Trails of clams and similar animals and burrows of worms fall in this class.

The process of fossilization is necessarily slow and has been going on for ages. Some fossils are very old, their age estimated in millions of years; others are quite recent. Fossils are dated from a study of the deposits in which they are found. The relative ages of the stratified rocks is determined by their order of superposition. From a study of deposition, superposition, and fossil content, geology furnishes us with a chronology of the earth—a sort of time table of notable events. We must keep in mind the fact that the age of the earth must be measured by at least tens of millions of years, and that throughout this time organisms have continuously changed.

The oldest era is the Archeozoic or era of "primitive, beginning" life. The Proterozoic era contains "less primitive" life. It is followed by the Paleozoic or era of "ancient" life. The Mesozoic is the era of "middle" life and the Cenozoic of "recent" life. The eras are divided into periods. Smaller recognized divisions include epochs and ages.

The Archeozoic and Proterozoic Eras contain just vestiges of life. Life is implied in the Archeozoic but determinable fossils are not known. During a part of this era, at least, the climate was favorable for the existence of life. Intense metamorphism may have obliterated many traces. The Proterozoic fossils include worm tracks, a brachiopod and fragments of crustaceans. Some algae and radiolarians are known also. These indicate that life was well advanced before the Cambrian Period of the Paleozoic.

The Paleozoic shows a great development of life. In the Lower Paleozoic simple invertebrate forms predominate. The Upper Paleozoic shows more complex invertebrate forms and a development of vertebrates. The Paleozoic includes such forms as foraminifers, sponges, jelly-fish, graptolites, corals, echinoderms, worms, brachiopods, pelecypods, gastropods, cephalopods, crustaceans, arachnids, and insects. In addition there were fish, and amphibians and even reptiles in the Permian. The trilobites and brachiopods were particularly prominent in the early periods. The Devonian shows the development of simple vertebrates particularly fish and ostracoderms. The Mississippian and Pennsylvanian are called the Coal Ages for they contain the world's greatest coal deposits. Plants are abundant during this time and include Thallophytes, Bryophytes, Pteridophytes (Lycopods, Equisetae, and Ferns)

and simpler Phanerogams (i.e., Gymnosperms). Amphibians (Stegocephalians) are also known from this time. Insects are found in the Pennsylvanian. Reptiles, some possessing distinct mammalian characteristics, are known from the Permian.

The Mesozoic is known as the Era of Reptilian Life. In addition to new species of types of plants and animals known in earlier times, the Mesozoic possessed marine reptiles (Enaliosaurs), land reptiles (Dinosaurs), and flying reptiles (Pterosaurs). Many of these attained great size, some dinosaurs showing a length of over one hundred feet. Great bodies with small heads, long necks, and long tails characterized these animals. The flying reptiles were an interesting development but became extinct by the end of the era. The Jurassic Period shows the first of the feathered creatures, namely the Archeopteryx, a reptilian bird. Other bird forms are known in the Cretaceous. Turtles date back to the middle Triassic. Lizards are known from the Triassic and crocodiles from the Jurassic. Snakes appeared in the Cretaceous. Some primitive mammals are known from the Jurassic and Cretaceous. By the end of the Mesozoic the great reptiles became extinct due to such factors as climatic change, over-specialization, internecine warfare, and the probable eating of their eggs by mammals.

The Cenozoic witnessed a great rise of mammalian life in addition to many new species of types of plants and animals already known. Conditions seem to have been particularly favorable for the development of warm blooded animals dependent on a large supply of oxygen in the air. Greater activity and greater intelligence contributed to their rise. The early Tertiary mammals were of monotreme and marsupial types but were soon replaced almost entirely by placental mammals. Some interesting developments are found in the evolution of such types as the horse, the camel, and the mastodon. Of particular interest is the primate group containing lemurs, monkeys, anthropoids, and man. The Quarternary Period included the Glacial or Ice Ages, during which time early man lived. A study of the rise of man (Pliocene, Pleistocene, Recent) brings us down to the period of Recent time.[1]

[1] The life of the Cenozoic Era is dealt with in more detail in the unit following this one, "The Age of Mammals and Man." (See SCHOOL SCIENCE AND MATHEMATICS, March, 1930.)

PRESENTATION OF THE UNIT: METHODS AND TECHNIQUE

The teacher may utilize the outline here presented or such portions that might fill his need, as a part of the regular course of study or for brief lectures in connection with biological topics. The time given to this particular unit will vary, depending largely upon the length of time allotted to the entire course as well as upon the interest of the student and instructor and the materials at hand with which to present it.

The foregoing unit is one of a series of two units dealing with such material in the last half of the ninth grade biology course in the Austin schools. The unit immediately following this one was published in the March, 1930, issue of School Science and Mathematics.

The unit is given a time limit of thirteen hours. On the day that it starts, a mimeographed outline (the outline printed above) is passed out to each student. Thus all references are before the student. The instructor utilizes the first hour in a discussion of the entire outline, making of it a brief but connected story. The success of the unit is partially dependent upon these first impressions gained by the student. If the whole past history of life and its development is placed before the student in a brief but composite whole, chronologically organized, we have found they are able to see it more clearly than if overburdened with detail at the first of the unit. While this is probably true for almost any unit, the very nature of this particular one makes such a procedure necessary. It is useless to think that the young mind will grasp the infinity of time so essential to a major understanding of paleontology unless there be given some systematic basis, such as a line-up of the geologic periods in chronological order. For such a study of geological eras obviously requires a chronological approach to be psychologically sound.

Following this discussion of the outline in which it is presumed that all reading assignments have been made clear, there begins the period of supervised study with the outline as a guide. This may progress for several days with little class discussion, depending upon how well equipped the biology department is in the source materials called for. Fortunately many of the books and pamphlets are very reasonable in price and may be purchased in multiple copies. Lucas' *Animals of the Past* should by all means be available in multiple copies even

if few of the other books listed are. Better students will soon exhaust the student references and will wish to read from those assigned as teacher references. One or two copies of these books will suffice.

Fossils should be used whenever available. Nearly every biological department will be able to obtain some local fossils for illustrative use. When not found locally, they may be obtained from biological supply houses. Charts, models, and skeletal materials are also available from these companies. The Austin region is especially rich in fossils, consequently considerable attention is given to this phase of the work. Great benefits may be obtained from first-hand information when laboratory hours permit of short field excursions into known fossil-bearing regions. Digging for fossils is a fascinating game, particularly for students.

Perhaps the greatest aid in the teaching of this unit will be found in the use of lantern slides. Slides can be obtained from the American Museum of Natural History, the Keystone View Company, and from other sources. Where a photographic laboratory is available, pictures may be taken from various books and made into lantern slides with very little expenditure. Slides showing nearly every extinct animal mentioned in this unit may be obtained from the American Museum of Natural History. Thus Brontosaurus, Stegosaurus, Triceratops, etc., when their reconstructions are flashed upon the screen, become far more than long-named extinct reptiles, dead a hundred million years.

Most of these subjects may also be obtained from the American Museum in mounted photographs suitable for hanging above the blackboard or on bulletin boards about the room. There are also several motion pictures available that fit in nicely with certain parts of the unit. Extension departments of colleges and universities as well as a few commercial houses are able to furnish films suitable for use. Films may be obtained in 16 and 35 mm. For example, the 16 mm film "The Lost World," important for showing Mesozoic animals, may be rented for a nominal sum from the Eastman Kodascope Libraries. Students never fail to enjoy this picture.

Where lantern slides, films, or mounted photographs can not be obtained with ease, illustrated material may be cut from papers, pamphlets, journals, and books and pasted upon card-

board for class distribution. We cannot overemphasize the use of graphic materials in presentation.

The authors believe that many teachers of biology will find this unit to be useful mainly as supplementary material to the general course. Obviously such material must be used intelligently and with discretion. It must of necessity be preceded by certain introductory biological studies involving the basic principles of the science. For example, this unit assumes some knowledge of the classification of plants and animals. If used for supplementary lectures in high school biology, we recommend its use somewhere near the end of the year course. We feel that the sustained interest shown by our students in the material outlined above justifies the inclusion of such paleontologic studies in almost any course in high school biology.

BIBLIOGRAPHY

References for the Instructor:

1. HEAL, EDITH. *How the World Began.* Chicago: Thomas S. Rockwell Co., 1930. (A simple and elementary account of past life, important for introductory reading.)
2. KINSEY, ALFRED C. *Introduction to Biology.* Lippincott, 1926. (Has some excellent chapters dealing with material presented in this unit.)
3. LUCAS, FREDERIC A. *Animals of the Past.* Handbook Series No. 4, American Museum of Natural History, New York: 1922. (Probably the most important book to be obtained for general use, dealing with this subject matter. It is interesting and readable for both instructor and student. Reasonable price allows for use in multiple copies.)
4. LUCAS, FREDERIC A. *The Hall of Dinosaurs.* Series No. 70, American Museum of Natural History, New York. (Contains excellent photographs of Mesozoic Life.)
5. LUCAS, FREDERIC A. *Guide to the Hall of Mammals.* Guide Leaflet No. 57, American Museum of Natural History, New York, 1926. (Contains a comprehensive classification of mammalian forms.)
6. LULL, RICHARD SWANN. *The Ways of Life.* New York: Harper and Brothers, 1925. (A comprehensive survey of the development of life. Valuable to the instructor.)
7. MCCABE, JOSEPH. *The A B C of Evolution.* New York: G. P. Putnam's Sons, 1921. (A well written account of the unfolding of life.)
8. MATTHEW, W. D. and CHUBB, S. H. *The Evolution of the Horse in Nature and Under Domestication.* Guide Leaflet No. 36, American Museum of Natural History, New York. (Valuable information on the evolution of the horse, with fine photographs.)
9. MILLER, WILLIAM J. *An Introduction to Historical Geology.* New York: D. Van Nostrand Co., 1922. (Of prime importance as a reference work for the instructor. Contains a discussion of geological eras with characteristic plant and animal life.)
10. NOE, ADOLF CARL. *Ferns, Fossils, and Fuel.* Chicago: Thomas S. Rock-

well Co., 1931. (The most entertaining and readable account yet published of the evolution of plants from the primitive algae to the complex flowering plants. Authoritative, scientific and at the same time simply told.)

11. OSBORN, HENRY FAIRFIELD. *Mastodons and Mammoths of North America.* Guide Leaflet No. 62, American Museum of Natural History. New York. (Mainly valuable for its illustrations.)
12. PIRSSON, L. V. and SCHUCHERT, C. *A Textbook of Geology.* Part II. New York: Wiley and Sons, 1924. (A college geology text giving an account of the earth and its life. Very useful as a reference.)
13. ROY, SHARAT K. *How Old Are Fossils?* Field Museum of Natural History, Geology Leaflet 9, Chicago, 1927. (A lucid account of conditions of fossilization.)
14. TRANSEAU, EDGAR N. *General Botany.* Yonkers-on-Hudson: World Book Co., 1925.
15. WASHBURNE, CARLETON W., and HELUIZ, C. *The Story of the Earth.* New York: Century Co., 1923. (A very elementary description of past life in story form.)
16. WARD, HENSHAW. *Evolution for John Doe.* Indianapolis: Bobbs-Merrill Co., 1925. (A good popular account of evolution.)

References for the Student:

1. HEAL, EDITH. *How the World Began.* Chicago: Thomas S. Rockwell Co., 1930. (Simple and elementary. A book that will be highly appreciated by the student.)
2. BROWN, BARNUM. "Hunting Big Game of Other Days." *National Geographic Magazine,* Vol. 25, 1919, pp. 407-429. (This article contains many excellent pictures in addition to description of fossil hunting in Alberta, Canada.)
3. KINER, GRACE. *How The World Grew Up.* Chicago: Thomas S. Rockwell Co., 1930. (A simple authoritative account of the early life of man in excellent form for student reading. Well illustrated.)
4. LUCAS, FREDERIC A. *Animals of the Past.* Handbook Series No. 4, American Museum of Natural History, New York, 1922. (Well written and not too involved for student use.)
5. ROY, SHARAT K. *How Old Are Fossils?* Geology Leaflet No. 9, Field Museum of Natural History, Chicago, 1927. (Students will be interested in this account of fossilization.)
6. WASHBURNE, CARLETON, and HELUIZ, C. *The Story of the Earth.* New York: Century Co., 1923. (An elementary description of past life in story form.)

THE OCTOBER NUMBER

SCHOOL SCIENCE AND MATHEMATICS is not published in September and never has been. Nine issues, October to June inclusive, are published each school year. If you do not receive your copy before the fifteenth of the month, please notify us at once. A long delay causes extra expense and disappointment. We try to avoid errors but your help is needed. Write SCHOOL SCIENCE AND MATHEMATICS, 3319 N. Fourteenth Street, Milwaukee, Wis., if your copy does not reach you.

THE GLASS OF FASHION

By Jean Broadhurst
Teachers College, Columbia University, New York

Despite the title this is not an advance announcement of styles sartorial. It presents no "mould of form" for your delectation or emulation. It is merely a discussion of the obvious trend in present day advertising,—what might even be termed the mad rush of advertisers to the microscope.

Two and a half centuries ago, when the microscope was still "that new and wonderful invention." Pepys wrote enthusiastically about the "most curious bauble" he had just purchased, "the best in all England." But although he sat up until two o'clock reading about the things to be seen with it, even his enthusiasm never led him to predict that the time would come when the big men of business, the kings of commerce—undeniably pragmatists all—would likewise sit up o'nights with their eyes glued to the eyepiece of that same curious bauble.

How else can we explain the almost ubiquitous microphotographs in present day advertising? Leaf through the popular illustrated magazines, especially the large-page weeklies and monthlies, and count the advertisements which seek to break down sales resistance by portraying the peculiar and characteristic minute structure of their products—picturing anything and everything from the outer reflective, non-absorptive surface to the very core—crystalline, spatially porous, or otherwise.

"Look on this picture and then on that," each advertiser directs, providing you with two microscopic photographs; by the first you may satisfy yourself concerning the superior values and advantages claimed for the product offered you, and by the second you are to be convinced of the inferior quality of the product or products of any and all competitors. To the thoughtful, the curious thing about it all is that two photographs always suffice; there is no middle ground—there are no grades of inferiority. All other products are equally and damnably bad. Buy any but the one the advertiser produces and you throw away your money, double your work, waste your time, alienate your friends, damage your property, endanger your children, injure your health, and hurry yourself and your entire household to an early grave.

Producers of milk (whether fresh, evaporated or acidophi-

lus), salad dressings, baking powders, yeast, watches, boilers, pistons, oil filters, gasolines, railroad ties, toilet papers, towels, pillow cases, silk hose, vacuum cleansers, dish washers, clothes washers and wringers, insulating materials for refrigerators and buildings, ultra-violet apparatus, disinfectants, moth destroyers, soaps, silver polish, floor wax, paints of all types, household abrasives, skin lotions, shaving creams and even razors, invoke the aid of the microscope. With it, they prove to you the quick action, the superior quality, the lasting values or the absolute harmlessness of the product offered. Thus may we be warned or assured regarding the crystalline structure of metals, the calcareous organisms in silver polish, the size of the air spaces in wall and refrigerator materials, the fat droplets in milk, the bubbles in shaving lather, and even the angles at which razors cut hair! Shades of Ezekiel, who commanded the son of man to take a sharp knife, a barber's razor, and divide a hair!

Comparisons *are* invidious, and there are legal perils for those who make them. But safety has often been secured by making the comparison insidious. Such advertisers play with a more delicate touch upon our credulity or our ignorance, some of them contenting themselves with the emphasis values of that little word, *the,* so rapidly becoming overworked in this connection. We read of *the* soap for delicate skins, *the t*obacco for the discerning smoker, *the* pen that will last a lifetime, *the* screens that never rust, and *the*—interminably! There's a Ph.D. thesis in the changing values of the article *the*—still called a limiting adjective by grammarians, although in advertising its limit is the sky, as witness, "*the* non-freeze oil for altitude records."

But with the microscope at hand, the advertiser gains confidence. He dares to assert definite specific claims, even wholly unrelated or unmeaning ones, if they have psychological appeal, for has he not the microscope pictures to prove them? It is more than a dramatic sense that leads him to picture the points in favor of his product. It is not really because he feels that the movies have made us eye-minded. It is because he still believes in the efficacy of the printed word and the continuance of our age-old dominance by it. Who does not know that old tale of the avaricious Italian who envied the property of a neighbor and brought suit to obtain it, presenting in evidence of ownership—being somewhat of a psychologist—a will pur-

porting to be that of one Peter, an uncle of the Caesar then reigning in Rome. That Caesar had never had an Uncle Peter availed the rightful owner not a whit. There was the document, date and all, even to the signature on the dotted line, and nothing could gainsay that evidence!

Naïve, was it not? But still quite characteristic of our mental processes, even today. Even those of us who profit by the shocks of experience and grow a trifle sceptical, are caught by the same advertising device. Very sharp and knowing we feel as we boast that "we like to see for ourselves," that we "have to be shown," and manufacturers and producers flatter us by proceeding to do the showing—through the microscope, which cannot lie, and reveals as it magnifies.

There, they imply, we get "the truth, the whole truth, and nothing but the truth." But do we—all—and always? A study of several of these microscopic pictures leads one to question it. One investigator, checking up on what is probably the most widely known of these pictures, said, "I've compared dozens of samples with the photograph given, and all I can say is, that like Moses, 'I saw no similitude.' "

Even when literally true, an advertisement may be quite misleading. Fat globules may be as numerous or as large as pictured in the tiny photograph, but, after all, does that insure four per cent milk fat in the bottle left at our door daily? This scouring powder may not have any of the sharp grit depicted, but does that prove that no corroding chemical is present to destroy enamel surfaces? The shaving soap bubbles may be as small as the one shown, but are small soap bubbles really desirable?

The ignorant and unsophisticated reader does not stop to think of such important alternatives and usually "believes the printer,"—often to his undoing, and frequently to the emptying of his purse, without adequate return or justification. Why, alas, should one multiply his food bill by ten, by purchasing foods which the advertiser promises "will not explode in the stomach," when no food ever explodes in the stomach?

Restrain your impatience with our human frailties, however. The customer isn't wholly to blame for his unsophisticated delusions. He may seem unpardonably gullible. But this is "the day of small things" predicted by Zechariah. Today, when the senses and even the imagination lose themselves in the solar

wastes within the molecule and become dazed by the whirring systems revolving within the atoms, even the most doubting conservative among us is ready to believe anything, and even the very elect may be deceived.

All advertisers do not mean to deceive. Some of their claims are true both in fact and import. But even when conscious that they are leading us to "see through a glass darkly," they sometimes lack "the will to refrain"; and so frail is man, that occasionally even when advised by scientifically trained people that the labels of a given pair of pictures ought to be reversed (!), the advertiser continues to use the original false labelling. It may once have been true that "the just shall live by faith," but certainly the unjust make quite a good living by that same means—the unfounded faith of others!

A friend once told me of an unsophisticated little Scotch lady who refused to look a second time at the unsuspected world revealed to her in a droplet of bacteria, saying in explanation, "It's no' canny." Her awe is now commercialized, and microscopes have become very canny—for advertisers. They know, too, how few buyers possess a microscope, and, daily, new claims are advanced, for every new product seeks a microscope "its glories to unfold." Unconsciously they sound again the warning of Emily Dickinson:

> Faith is a fine invention
> For enabling men to see.
> But microscopes are prudent
> In an emergency.

Readers, that emergency is here. But remember that microscopes are truly prudent—we're prudent—only when we squint through them ourselves.

ELBERT HUBBARD'S CODE

I wish to live without hate, whim, jealousy, fear. I wish to be simple, honest, frank, natural, clean in mind and body, unaffected to say "I don't know," if it be so, and to face any obstacle and meet every difficulty unabashed and unafraid.

I wish others to live their lives, too, up to their highest, fullest and best. To that end I pray that I may never meddle, interfere, dictate, give advice that is not wanted, or assist when my services are not needed. If I can help people, I'll do it by giving them a chance to help themselves; and if I can uplift or inspire, let it be by example, inference, and suggestion, rather than by injunction and dictation.

RELATED MATHEMATICS IN THE CO-OPERATIVE SHEET METAL COURSE

By Barnet Rudman
South Boston High School, South Boston, Massachusetts

Teaching Related Mathematics is pioneering into unchartered regions. The reward is complete freedom from the inhibitions and circumscriptions of the traditional mathematics, but the price exacted is the assumption of new responsibilities and one's renouncing pioneer-like the security that comes with guidance, experience, and expert advice. In a standard algebra course one is told to teach formulas, negative numbers, simple equations, verbal problems, pairs of equations, graphs, quadratics, progressions, and logarithms. Having taught these, the classroom teacher is absolved from further responsibility. The Schorlings, the Barbers, the Ligdas will now go before the tribunal of public opinion and argue that the young generation must have this sort of quantitative training in order to understand and control the life surrounding it. In Related Mathematics the teacher is given a class of sheet metal workers and is asked to teach all the mathematics a foreman in the trade needs to know and . . . . no more. But what mathematics a sheet metal foreman needs to know no one can tell. Textbooks are not available and the literature on the subject is very scarce. The problem is further aggravated by the kaleidoscopic changes that take place within the sheet metal industry itself. A foreman's mathematical equipment of today may be utterly inadequate five years hence or altogether superfluous. Yet, with no clearer objectives to guide him, the classroom teacher is to evolve his own program of study and prepare to give it a respectable status.

To lighten the task somewhat I framed for my own guidance the following specific aims:

1. To develop proficiency in contracted multiplication, division, and extracting square roots.
2. To develop ability to multiply and divide by the method of logarithms.
3. To help pupils form the habit of rapid and rough estimating as a check on numerical computation.
4. To teach the meaning of approximate numbers and emphasize the folly of attaining a high degree of arithmetical accuracy where it is most generally rendered meaningless by questionable accuracy in measurements taken.

5. To develop in pupils ability to apply their knowledge of percentage to problems arising in their shop work.

6. To develop proficiency in applying to real situations the formulas for areas of triangles, rectangles, and circles and that for the circumference of a circle.

7. To develop proficiency in applying to real situations the formulas for areas and volumes of the cylinder, cone, frustum of the cone, and the sphere.

8. To teach the practical importance of the Pythagorean Theorem, the properties of the 60°–30° right triangle and of the isosceles right triangle.

9. To teach extracting square roots by logarithms.

10. To teach in connection with real situations the solution of right triangles with the aid of the tangent, sine and cosine.

And the general objectives:

1. To bring about the mastery of mathematics incident to common projects in sheet metal work.

2. To develop the ability to use acquired skills and controls in projects similar to those already studied.

3. To train pupils in the technique of writing neat and intelligible reports.

4. To discourage wastefulness by pointing to the cost of waste in any industrial project and the need of reducing it to a minimum.

THE FIRST YEAR

During the first year of the co-operative course some of these objectives could be attained through the medium of an elementary algebra course similar to that given to "college preparatory" freshmen. Because this initial year is not state-aided the course of study is free from the jurisdiction of the State and hence could include material of general and cultural value. In view of the future needs of the boys, however, it seems wise to change the order of the topics and to place increased emphasis on approximate computation and the formula.

In the South Boston High School we begin (in Barber's "Everyday Algebra") with approximate computation. Direct experimentation in class with 12-inch rules shows the approximate nature of measurements and points to the need of modifying the fundamental operations so as to obtain results consistent with the accuracy of the measurements. The stage is thus set for contracted multiplication, division, and extracting of square roots. In connection with this work we help our pupils recall the method of changing common fractions to decimals stressing, in particular, decimal equivalents of measurements taken to the nearest sixteenth of an inch, and the converse.

Algebra proper is introduced through the formula. Geometric formulas are emphasized for obvious reasons. We provide con-

siderable drill on areas of rectangles, triangles, circles, and trapezoids, and incidentally teach economical cutting of stock and "figuring" percentage of waste. So, too, we drill on volumes of rectangular solids, cylinders, and cones.

The purely algebraic equation receives less attention than it does in the standard algebra course. Yet we stay long enough with it to insure understanding of the simpler forms with parentheses and of the fractional equation with monomial denominators. We also use the equation as a means of explaining the laws of signs governing operations on negative numbers.

The graph occupies a prominent place in the program. Considerable work is done with linear graphs (inches against centimeters; circumferences of circles against radii). The graphical solution of simultaneous linear equations is stressed both for its own value and as an introduction to the algebraic method of solution. Because of the length of time given to approximate computation and the formula we are forced to slight the verbal problem. We use it to introduce equations and the graphical solution of simultaneous linear equations. We teach our pupils to translate ready-made equations back into word problems. The systematic study of setting up equations, however, is a luxury we cannot afford.

THE SECOND YEAR

Beginning with the second year the course is characterized by two significant changes. First, state aid is now forthcoming, and the state exercises, with the city, joint control over the work. Second, classes are, from now on, attended every other week, academic work thus alternating with shop activities. Particularly this latter change revolutionizes classroom procedure. Returning from a week's manual work in the shop these boys appear restless and incapable of sustained intellectual effort. Mathematics now becomes strictly "related." We can hope to succeed only with short practical projects arising from shop situations or trade drawing.

The first two weeks are spent to good advantage on review of approximate computation Then areas of plane figures such as rectangles, triangles, trapezoids, circles, and polygons are studied in their natural settings such as, for instance, in determining the weight of pieces of sheet iron of different gauges. So, too, we study lateral areas of rectangular solids, cylinders, cones, and pyramids for the purpose of ascertaining (a) the

amount of material to be used and (b) the cost of material. Contracted multiplication is used almost exclusively. This may be followed up with a simple project like calculating the amount and cost of material necessary in the construction of an ash barrel, also the probable cost of labor.

Proficiency in the use of compasses and ruler is indispensable to success in trade drawing. To help the boys develop such proficiency we teach them the fifteen standard geometric constructions (without proof):

1. Bisect a line and draw the perpendicular bisector.
2. Bisect an angle.
3. Construct a perpendicular to a given line through a given point.
4. Construct an angle equal to a given angle.
5. Through a given point draw a line parallel to a given line.
6. Construct a triangle given (a) the three sides, (b) two sides and the included angle, and (c) two angles and the included side.
7. Divide a line into an equal number of parts.
8. Given an arc of a circle, find its center.
9. Circumscribe a circle about a triangle.
10. Inscribe a circle in a triangle.
11. Construct a tangent to a circle through a given point.
12. Construct a polygon similar to a given polygon.
13. Inscribe a square in a circle.
14. Inscribe a regular hexagon in a circle.
15. Construct angles without the use of a protractor.

The subject of ventilation, blower work, and heating are particularly rich in opportunities for teaching applied mathematics. Cross sections of pipes can be made to teach more about the circle than a whole chapter in Euclid's Geometry. What happens to the capacity of a pipe, if its diameter is doubled? What must be the diameter of a pipe, if it is to convey three times as much steam as a given pipe? Why does doubling the diameter of a pipe give it a capacity four times the original capacity? Problems like these are fascinating to the boys who make pipes, and are exceedingly instructive. When the significance of the r^2 in the formula πr^2 is fully appreciated the more difficult problem is introduced, that of finding the radius of a pipe which is to have a capacity equivalent to the combined capacities of two given pipes. The algebraic method is puzzling as a rule. The more alert boys may be able to follow the process $\pi a^2+\pi b^2=\pi c^2$ or $c=\sqrt{a^2+b^2}$ but they feel inadequate as a rule to use it for a practical tool of computation. So they are given the steel square method. They measure off the given radii perpendicular to each other, and the hy-

potenuse of the resulting right triangle is the required radius. Algebra, of course, is invoked to lend the touch of authority to the procedure. The duller boys view this application of the right triangle to the solution of circles as being little short of a miracle. The brighter boys begin to feel the power of mathematics.

THE THIRD YEAR

In the junior year the work becomes truly co-operative. The more promising fledglings are now sent forth to try their wings in the industries. Some sheet metal establishments in the city are giving, whenever conditions permit, part-time employment to such seniors and juniors as the co-ordinator may recommend. The co-ordinator who is the responsible head of the industrial department picks for the available jobs the most deserving pupils; the less fortunate ones spend their shop weeks in the school shop. On alternate weeks, however, they all report to the classrooms for their "academic" training. And the State insists that most of this training be "related."

With the exception of the chronic sluggards the pupils are now skilled in the use of contracted multiplication, division, and extracting square roots. We begin, however, with a rapid review of these operations emphasizing rough-estimating and placing decimal points in products, quotients, and roots. This serves as an appropriate introduction to the study of logarithms. Needless to say we do not go into the theory of exponents and the many derived generalizations concerning logarithms. In multiplication and division we omit characteristics altogether. Pupils learn rapidly how to find mantissas for numbers and how to change mantissas resulting from operations back into numbers. Decimal points are placed, as in contracted multiplication and division, by inspection, that is by estimating from the original factors or from the dividend and divisor. These are the minimum essentials, and we teach no more. We cannot, however, avoid characteristics in the study of square roots. So we go sufficiently far into the laws of exponents to explain the meaning of characteristics and the reason for dividing the logarithm (characteristic and mantissa) of a number by two when its square root is taken. The rest of the process is known from the use of logarithms in multiplication and division. Logarithms are popular with the boys and are used throughout the year as a means of checking numerical computation.

Having thus improved the calculating powers of our pupils we undertake next some advanced work on areas. Zones, sectors, segments, and combinations of these with other figures are studied to insure understanding of the many plane figures that are eventually transmuted into three-dimension bodies of various shapes. The ellipse, the hyperbola, the parabola, and the circle are all used in trade drawing, and causing these to emerge from algebraic equations is very fascinating to the boys. We do not ask them to duplicate the process, but a few informal class demonstrations can be justified for their worth as lessons in appreciation.

Several real projects characterize the mathematics of the junior year. The first is the Tin Cup Project. It is intended that in about three weeks the pupils become skilled in all the mathematics incident to the making of and estimating the cost of material for 1000 tin cups of various specifications. Mimeographed sheets of which each pupil has a set contain the plan for the body and bottom of the cup as well as the learning exercises for the first week. Tables of dimensions, weights, and costs of the different kinds of material complete the data to be used in the project. In the end a report is required of every pupil on the amount of material needed, cost of material, percentage of waste, etc., for a cup of certain specifications. To encourage independent work these specifications are different for different pupils.

The project calls for some very definite mathematical skills and provides opportunities for their further development. To do it justice the pupils must be proficient in the use of formulas for areas of circles and rectangles and for circumferences of circles. They must understand percentage, be able to change common fractions into decimals, and otherwise be well versed in the technique of approximate computation. They must appreciate the need of cutting down waste. In the course of the work sufficient practice is given in reporting on this kind of a problem.

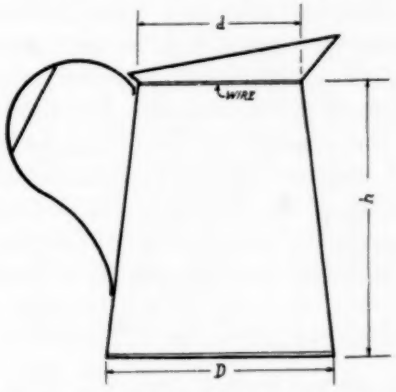
The second project deals with standard flaring liquid measures. The frustum of the cone is thoroughly studied in this connection. I am including a mimeographed sheet to show the type of drill material that accompanies these projects. The formula used to determine capacities is the one giving the volume in terms of the radii of the bases, that is

$$V = \tfrac{1}{3}\pi h\ (r^2 + r_1^2 + rr_1).$$

The same formula can be used to find heights when capacities and diameters of bases are given. It will be noted that we steer clear of the problem calling for one of the two diameters when the other diameter, height, and capacity are given. The explanation is very simple. Our pupils do not as yet know how to solve quadratics and would be unable to handle this latter problem. We introduce the frustum again in the senior year after we have taught the solution of quadratic equations thus providing the tool for evaluating unknown diameters.

Other projects are given periodically dealing with cans and utensils and featuring diverse geometric shapes.

STANDARD FLARING LIQUID MEASURES



Find the capacities of the following measures

	d	*D*	*h*	*Capacity*
1.	2-1/16"	2¼"	2"	
2.	2¼	2½	3¼	
3.	2-11/16	3	4-9/16	
4.	6¾	8¾	9¾	
5.	8½	11	12-5/16	

What height would you make the following measures to hold the necessary capacity?

	d	*D*	*Capacity*	*Height*
6.	3¼"	4"	1 quart	
7.	3¾	5-3/16	2 quarts	
8.	5	6½	1 gallon	
9.	8	10½	3 gallons	
10.	9½	12½	5 gallons	

We have combinations of cylinders and frustums of cones, of cylinders and spheres, of rectangular solids and cylinders, and

of rectangular solids and frustums of pyramids. This year's work, in short, is fairly dominated by applied geometry.

THE FOURTH YEAR

We begin this year as we began in former years by bringing our pupils back to a "calculating" frame of mind, the medium being approximate computation. Logarithms are now included in our bag of tricks. This review is supplemented by a study of numerical trigonometry. By direct experimentation the constancy of the various functions of a given angle are established, and appropriate drill is provided for the application of the sine, cosine, and tangent in the solution of right triangles. The boys, to be sure, find little use for numerical trigonometry in their shop work, but what they learn about the use of tables and interpolation may some day be very helpful.

A knowledge of quadratics sometimes proves a blessing to the intelligent sheet metal foreman. We, therefore, feel it our duty to teach the solution of quadratics by factoring and by the formula. A review of some elementary algebra ushers in a short discussion of the simpler cases of factoring which are immediately applied to the solution of simple quadratic equations. This is followed by the solution of more difficult quadratics by the formula $X = \dfrac{-b \pm \sqrt{b^2 - 4ac}}{2a}$. Applications to trade problems are not hard to find. We bring out the frustum problem that we deliberately avoided in the junior year:

> What would the upper diameter of a flaring standard measure have to be, if it is to hold two gallons, and have a height of 9¾″ and a lower diameter of 8¾″?

Without quadratics the problem is inapproachable. One who knows quadratics, however, and is not afraid of decimal fractions can solve it with comparative ease.

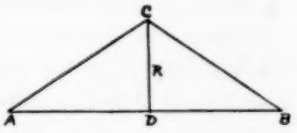
$$\begin{aligned} 1V &= \tfrac{1}{3}\pi h(\mathrm{r}^2 + r_1^2 + rr_1) \\ 462 &= \tfrac{1}{3}(3.14)(9.75)(4.38^2 + r_1^2 + 4.38r_1) \\ 1386 &= (3.14)(9.75)(4.38^2 + r_1^2 + 4.38r_1) \end{aligned}$$

By evaluating 3.14×9.75 and dividing the result into 1386 (by logarithms) we get a numerical value for $4.38^2 + r_1^2 + 4.38r$. The equation is then changed to the form $ax^2 + bx + c = 0$ and solved by the formula. There are many

other similar problems that yield to the charms of the quadratic formula.

The projects this year deal mainly with skylight work. We begin with the simple flat skylight. The calculations of needed materials, weights, and costs involve little more than areas of rectangles and contracted multiplication.

The double-pitch skylight presents a more interesting problem. The ability to solve right triangles (for lengths of sides) is indispensable here. Ratios, too, must be understood. The dimensions of the skylight and its pitch are given, and from this data one must calculate the lengths of the various bars in order to determine the amount of material required. The most popular pitch is $\frac{1}{3}$. Now, strangely enough, the "pitch" as known in the trade is not, as one might suppose, the tangent of the angle of inclination. It is the rise of the skylight divided by the span of the width of the skylight. Thus, if ABC is a cross section of the skylight, CD/AB is the pitch (equivalent, in fact, to one-half of our trigonometric tangent). To calculate the length of the bar AC, we get the rise CD from the given width AB and the given pitch (generally $\frac{1}{3}$), then with the aid of the Pythagorean formula we determine the length AC. All in all there is in this project much valuable mathematical training for prospective sheet metal workers. We also take occasion in connection with this work to teach simple radicals and the properties of the 60°-30° right triangle and the isosceles right triangle.

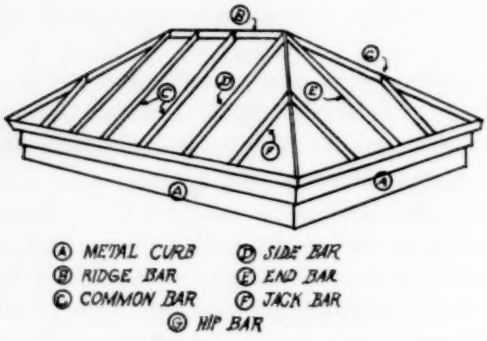


CD = Rise
AB = Span

$$\text{Pitch} = \frac{\text{Rise}}{\text{Span}}$$

or $P = \frac{R}{S}$

The hipped skylight is still richer in applied mathematics. As is evident from the adjoining blueprint there are seven distinct parts to the metal framework of the skylight. The length of the common bars, side bars, and end bars are determined as in the double-pitch skylight. To find the length of the jack bar (F) we use similar triangles with $\frac{1}{2}$, most often, as the ratio of similitude. The number of all bars except common bars is constant. The number of common bars is determined by the "spacing" or the width of the plates of glass. The length of the hip bar (G) may be determined by the formula $a^2 + b^2 = c^2$ or by a special trade formula $G = 1.56(\frac{1}{2}S)$



provided the pitch is $\frac{1}{3}$. The length of the ridge bar (B) depends on the shape of the skylight. In most cases it may be obtained by subtracting the width of the skylight from its length.

The problem becomes more complicated when a ventilator is built on top of the skylight. Yet when the common hipped skylight is well understood the transition to the one with a ventilator is merely a matter of another week's work. It is evident that a project of this sort calls for much concentration and manipulative ability.

HISTORY OF THE MOVEMENT AND THE PROBABLE FUTURE OF RELATED MATHEMATICS

The first co-operative industrial course was inaugurated by Superintendent Franklin B. Dyer in the Hyde Park High School in the year 1913-1914. The first course of study contains the following interesting statement: "As part of the regular work, excursions should be made to various industrial plants, and during the last half of the year one afternoon each week shall be devoted to work in some manufacturing establishment in Hyde Park without pay. In the second, third, and fourth years, co-operative shopwork should be conducted in connection with some Hyde Park manufacturing establishment $2\frac{1}{2}$ days each week—Friday, Saturday, and Monday, with pay."

The situation today, with a strong industrial department in every district school and with juniors and seniors out in the industries actually drawing pay on alternating weeks, points to the phenomenal growth of the co-operative movement.

The future of related mathematics is very uncertain. I suspect that we have gone too far in our attempt to make our

work strictly utilitarian. We may have to swing back in the direction of the traditional curriculum. Sheet metal practices involve a good deal of mathematics and the kind that needs a foundation. The lack of such foundation is evident in our present generation of students. It is quite the thing among progressive educators to advocate that quadratics be taught only when there is a need for it in real projects, or that the Law of Sines be omitted until students ask for it. But many are the trials and tribulations of the teacher who goes out to try these modern ideas in the classroom. Certainly he is not to be envied who is attempting to teach quadratics or ratios to a class ignorant of the laws governing fractions or of the meaning of such common terms as exponent, coefficient, dividend, quotient, and the like. The fact that the prospective sheet metal foreman, destined to use mathematics, is sent out of school with practically no foundation in algebra and geometry, while the future lawyer carries with him loads of mathematics he will never use, is one of the flagrant contradictions of current educational practices. Here surely is a situation clamoring for readjustment.

NOTE—For the drawings I am indebted to Mr. Thomas A. Roche, coordinator of the co-operative sheet metal course at the South Boston High School. Mr. Roche also furnishes the Mathematics Department with the many practical problems originating in the shop.

EAST'S LARGEST TELESCOPE AT NEW HARVARD OBSERVATORY

The largest telescope in Eastern United States, a sixty-one inch reflector, will soon be installed in the new Oak Ridge station of the Harvard College Observatory, the cornerstone for which was laid as a part of the ceremonies of the International Astronomical Union meeting. The new Harvard observing station is located twenty-six miles from Cambridge near the town of Harvard.

The new telescope will be the fourth largest in the world. It will supplement the sixty-inch reflecting telescope now being erected at the other Harvard observing station in South Africa. The South African telescope will be the largest in the southern hemisphere. With the two instruments, the Harvard astronomers will be able to reach all parts of the sky.

Sir Frank Dyson, astronomer royal of Great Britain, officiated at the cornerstone laying and Dr. Harlow Shapley, director of the Harvard Observatory, cached in the cornerstone astronomical records of historical importance.—*Science Service*

THE STORY OF AN ENGLISH CHRISTMAS TREE

By Shirley D. Babbitt, *Muncie, Indiana*

Characters

Uncle—A conservative English squire, formal, well dressed, a little gray.

Nephew—A dapper American, young, confident, well dressed.

Servant—A typical English servant, respectful, obedient, a general handy man about the estate.

Children—Four to six children from eight to twelve years of age may appear in scenes III and IV.

Singers—Four or five carol singers appear on the stage in scene III. Others may sing with them from off stage in the wings or behind the back curtain.

Other Characters—In scene III several other characters may appear and converse among themselves; all should be merry and enter into the spirit of the occasion.

The tree to be used should be about three or four feet high, a fine evergreen. It is in a box or tub on the stage with leaves and green burlap about it to represent the ground. In Scene II a small cart or truck is used to get the tree. On the truck is a box or tub slightly larger than the one in which the tree is planted. While the Uncle and Nephew are talking the gardener and children work between the tree and the audience and take up the tree container and place it in the similar container brought on the truck. The tree is not taken from the original container; container with tree is placed in a larger one.

Scene I

In a room of an English manor house. The Squire and his Nephew, a young American, are standing and talking before the fireplace, over which hangs a large family portrait.

Nephew. Well, Uncle, here I am at last. It hardly seems possible that it is true.

Squire. You are very welcome, quite welcome, indeed. We are especially pleased that you are to be with us over the Christmas season. It is splendid.

Nephew. It *is* splendid, Uncle. You know, I have always dreamed of visiting England. When I was a boy my grandfather told me about the country. He used to tell me about the gardens, about the land so carefully cultivated, about the

hedges instead of fences. He used to call it Merry England. Ever since he used to tell me about those things I have wanted to see England.

UNCLE. And now you are here, I hope you like it. You will find us a bit different, no doubt. Your grandfather was my elder brother; he went to America when I was just a lad. I never saw him after that and I scarcely remember him. I have never seen your father—I wish he could have come with you.

NEPHEW. He sent his best regards and said to tell you that he hoped to come sometime. Business keeps him pretty busy, you know.

UNCLE. How is he? Tell me about him. What about that oil—oil. What was it he called it? That oil bang. He wrote about it in his letter a year or two ago. Was it oil bang? Bang? No, that wasn't it—boom. Boom! That was it—what about the oil boom?

NEPHEW. Oh that blew up nearly a year ago.

UNCLE. Blew up! It blew up? I thought that was his business and that it was making him a fortune. Did it destroy all his property? Was anyone killed?

NEPHEW. It wasn't an explosion. When I said it blew up I meant it went under.

UNCLE. Went under when it blew up? How peculiar!

NEPHEW. I mean it failed—the business failed. You see Father had been in the lumber business. He bought and cleaned up most of the lumber in our part of the country. That is, the best of it. The rest was piled up and burned when the land was cleared. The lumber business was about finished when the oil boom came.

UNCLE. Did they pile up the trees and burn them?

NEPHEW. Yes, burned them to get rid of them.

UNCLE. But wasn't that very extravagant and wasteful?

NEPHEW. No, they wanted to clear the land—and besides the oil boom came then. They struck oil and then everyone went into oil.

UNCLE. Went into the oil? Isn't it terribly dirty, vile smelling stuff to go into?

NEPHEW. I mean they went into the oil *business*. You see many people got rich and that made others want to go into the business.

UNCLE. And that is what you call a boom?

NEPHEW. That is it. People get rich and money is so plentiful that all business grows rapidly and—

UNCLE. Did everyone get rich?

NEPHEW. No, not all. Father was lucky. He sold most of his interests before the boom broke.

UNCLE. Broke? The boom blew up, and went under, and broke?

NEPHEW. The oil failed. It was all used up. You see there was so much that everyone thought it would last forever. Everyone used all he could. No one tried to save it. Much of it was wasted. Then when the boom ended, business was dead and the oil men had to move to new territory. But Father sold his interests in time so he did not lose.

UNCLE. It is difficult for me to understand how you could burn the forests and waste the oil that way. What will you do when they are gone?

NEPHEW. Oh there are other regions where there are yet forests, and new oil fields are found every year.

UNCLE. But what are the future generations to do if you waste the forests and the oil? They are natural resources.

NEPHEW. In America we think little of the future. We live in the present. Each generation must look after itself.

UNCLE. But your country must have a future the same as this. This estate has been in our family since the time of William the Conqueror. I should hate to think of what it might be now if all of its owners had thought nothing of the generations to follow. Why, every day I reap enjoyment of things planned by your grandfather's father. He surely considered the future.

NEPHEW. It must be something in the people, the land, or the climate. Grandfather used to tell me that we were much more wasteful than the people of England.

UNCLE. Well, anyhow I am glad you are here. I shall learn much about your country and your people. You will find us a bit old-fashioned and peculiar, no doubt, but you will not find us wasting any natural resources. America is a young country. Countries are like individuals. As they grow older they become less impulsive. They consider more; they become less reckless, extravagant, and wasteful. They become more conservative.

[*A* SERVANT *enters and stands humbly with bared head.*]

SERVANT. Pardon, Sir, but we are now ready to go after the Christmas tree.

UNCLE. Yes indeed, James. Christmas will be unusually fine this year with our American guest. James, this is my nephew from America.

[*They greet each other, the* NEPHEW *nodding and the* GARDENER *bowing very meekly but graciously.*]

Nephew, this is Mr. Hargrave, my gardener. [*The* SERVANT *withdraws and the* SQUIRE *turns again to his* NEPHEW.]

We had arranged to go after the Christmas tree now; would you like to go with us?

NEPHEW. Yes, I would. Since Father was in the lumber business I would especially like to go into the woods.

UNCLE. We shall be very glad to have you, I am sure.

[*They leave the stage together and the curtain is drawn.*]

SCENE II

The curtain opens on a wood scene. A group of people including the SQUIRE, the AMERICAN, SERVANTS, and CHILDREN enter. The child runs up to the evergreen in the center of the stage and cries out and the rest form in a circle about the tree.

FIRST CHILD. Here is a good one!

SECOND CHILD. It isn't so good as that other one.

FIRST CHILD. Yes it is; it is bigger.

SQUIRE. There, there, children. Who ever heard of children trying to quarrel at Christmas time!

BOTH CHILDREN. We weren't quarreling; we like all the trees.

SQUIRE. Of course you do. This tree is taller than the other but it is not so far around. You see both of you were right. Now we'll ask Mr. Hargrave what he thinks about it. What about this tree, James?

GARDENER. This is a good tree. It is even and well balanced and will make a fine Christmas tree.

SQUIRE. Is it better, than the other one we considered?

GARDENER. No, it is no better, but it is out in the clear so we can get it better.

SQUIRE. Then we will take this one. [*The* GARDENER *begins carefully to measure a distance about the tree and marks a place to dig. He directs and helps in the transplanting of the tree into a tub which has been brought in the cart.*]

NEPHEW. Shall you chop it down now?

SQUIRE. Chop it down!

GARDENER. Chop it down!

CHILDREN. Chop it down!

SQUIRE. No indeed, we shall not cut it down; we shall dig it up.

GARDENER. Yes, dig it up!

CHILDREN. Dig it up!

SQUIRE. Take pains with it, James. Do not injure any of the roots.

GARDENER. Yes sir, and I'll keep the soil on the roots. [*As the workmen dig up the tree, the* CHILDREN *joyfully run about and give exclamation to their glee.*]

FIRST CHILD. Let us make it prettier than the one last year.

SECOND CHILD. Let us think of all the people we can make happy with it.

FIRST CHILD. I know some presents I am going to put on it.

SECOND CHILD. I have some already done up in packages.

FIRST CHILD. Let us ask if we can help put the trimming on. [*They carry on such conversation until the tree is dug up and in the cart. Then all but the* UNCLE *and the* NEPHEW *leave the stage with the cart and tree.*]

NEPHEW. I never knew of people taking so much pains and trouble with a Christmas tree.

UNCLE. No, in a country where they burn trees to get rid of them I suppose not.

NEPHEW. But what is the use of it? It is only a Christmas tree and Christmas is but a brief season.

UNCLE. [*As they leave the stage*]. You will be here over the Christmas season and will help us celebrate it. You can see why we do it. It is but a part of our conservation.

[*Curtain*]

SCENE III

Same as Scene I in the manor house. There is a fine Christmas tree near the fireplace. It has decorations, candles, etc., on it and beneath it are many packages. A footman enters and puts chairs and benches in order. Then he looks at the clock and sounds a gong. People of the family enter and greet each other and all wish each other Merry Christmas.

After the greetings are over the SQUIRE sounds a gong and the servants enter. Greetings are extended to the servants and all admire the tree and decorations.

The SQUIRE reads a short Scripture lesson and gives a brief prayer. The

CHILDREN then are directed by the SQUIRE that they may give out the presents.

Suddenly the SQUIRE raises his hand—

SQUIRE. Hark! I hear the Christmas singers.

[*A song is heard off stage and all are quiet during the singing of the carol. Again they make merry and talk and give out presents. Again they are hushed and another carol is sung from off the stage. Then the* SQUIRE *crosses the stage to the door and calls*—

SQUIRE. Come in and see our Christmas tree. We thank you for the carols; they were fine.

[*The singers come in and stand about viewing the tree and all are greeted cordially. The* CHILDREN *give each one a small Christmas package. The people leave the stage talking, singly and in groups, leaving the* SQUIRE, *his* NEPHEW, *two* SERVANTS, *and two* CHILDREN.]

NEPHEW. It's a great Christmas, Uncle.

UNCLE. Every Chrismas is beautiful, but this one is specially so to me because you are here. Each year the family gathers from different shires of England, but this is the first time we have had an American relative with us.

NEPHEW. I surely like your Christmas customs. They are great. It certainly is an excellent idea to take up the tree so carefully. It keeps much greener than ours and the needles don't drop off and scatter all over everything. You could, if you wanted to, keep this quite a while before you throw it out.

SQUIRE. Throw it out!

SERVANTS. Throw it out!

CHILDREN. Throw it out!

[*After an awkward pause of embarrassment the* NEPHEW *speaks*—

NEPHEW. Why, what shall you do with it?

SQUIRE. It has only begun to be a Christmas tree.

FIRST CHILD. We are going to have it at our school, and have singing, and presents, and exercises, and everything.

SECOND CHILD. We are going to take it to the hospital, too, and let all the sick people in bed have it for their Christmas tree then. I think that is the best Christmas tree of all.

SERVANT. The orphan home shall also have it. It may be there for several days.

SQUIRE. Yes, indeed! We would never think of letting its

leaves fall. Nor shall we throw it out. It will be a Christmas tree for a fortnight or more, but it will be just as fresh and green as when we brought it from the woods.

[*A bell sounds and all leave the stage but the* SQUIRE *and* NEPHEW.]

NEPHEW. You certainly do get much more use from a Christmas tree than we do in America.

UNCLE. [*As they leave the stage*]. That is not the best part of it by any means, as you shall see.

[*Curtain*]

SCENE IV

The same as Scene II. The servants have the tree in the small cart and they plant it where it was originally while the SQUIRE and his NEPHEW talk.

NEPHEW. The woods are surely fine. I never saw woods in America so natural and at the same time so clean and well kept.

UNCLE. In England we make use of all our woods. Every dead branch and tree is utilized. No one in England would think of destroying trees if he could prevent it.

NEPHEW. But you don't have so much woods as we have; you have to be more careful of them.

UNCLE. All of England was once covered with forests. It is a very old country. We have found by experience that every measure possible must be taken if we are to preserve our natural resources. That is why we are replanting the Christmas tree so carefully.

NEPHEW. But one small Christmas tree like that cannot be worth very much.

UNCLE. Perhaps not in sterling. But there are some things that have a value greater than money. It would take at least ten years to raise another small tree like that one. We have used it for a Christmas tree for more than a fortnight. Several hundred people have been made happy by it, and best of all, the tree is as good as ever. We can use the same tree next year.

NEPHEW. It surely is better than a ragged skeleton of a tree with half the dead leaves off the way many of ours are before the Christmas season is over.

UNCLE. Besides taking the place of a score or more trees, as you say you use them in America, we still have the tree as good as if we had never disturbed it. [*The tree is in place and the* SERVANTS *and the two* CHILDREN *are standing by it. The*

SQUIRE *notices them and they all stand in mute attention while one of the* CHILDREN *gives the finishing touches to the tree and they leave the stage; the* UNCLE *and* NEPHEW *resume their talk.*]

CHILD.

Who plants a tree, in the future lives—
To children's children a blessing gives—
Like bread cast on the wave;

And the sons of men as yet untold
Will receive rewards a thousand fold
And bless the hand that gave.

Who plants a tree renounces greed;
He blesses with memorial deed,
And shares his lowly crust.

Sweet charity and hope must be
In heart of him who plants a tree—
In him I place my trust.

NEPHEW. You say you can use this tree several years? Then it must grow very slowly I should think.

UNCLE. Yes, we often use the same tree several years, and the fact that it grows slowly makes it more worthwhile and desirable to save and preserve it.

NEPHEW. To be sure, Uncle, but it will never be large enough to benefit you any.

UNCLE. It has already benefited me and many others, and will continue to do so as long as I live. When I am gone, it will still benefit others. Do you see those large trees over there? They have given me pleasure since I was first able to romp in these woods. They were planted before the time of Oliver Cromwell. No one can tell how many people they have benefited. I can say this, however; unless someone had planted them and others had conserved them, several generations would have been deprived of the pleasure they have given.

NEPHEW. You are right, Uncle. We are terribly wasteful of our trees in America. When I go back I am going to profit from my visit; I am going to get people interested in conserving Christmas trees. America can get a great lesson from that tree, still living, and yet to serve others. [*He looks at the tree and points to it.*] See, the workmen have gone and forgotten to take off all the decorations.

UNCLE. That is a little tag and bell that tells the year the tree was used for a Christmas tree. You will find some trees with several tiny bells still on them. They tinkle in the breeze and carry some of the Yuletide spirit throughout the whole year. The children like them especially.

NEPHEW. You make your celebrations much longer than ours, and yet you manage to conserve your trees so you still have them.

UNCLE. [*The stage is half darkened as he speaks.*] Yes, we enjoy our festivals and make much of them. It is characteristic of our country. It is now more than a fortnight since Christmas, but as evening falls we can still hear Christmas music from the houses over yonder beyond the copse.

[*The stage is completely darkened as they pause to listen. The strains of "Silent Night" can be heard as from a distance.*]

BEGIN PRODUCTION ON SERIES OF WORLD'S FAIR MOTION PICTURES

Astonishing progress in industry during the past one hundred years brought about through man's ingenuity and development of scientific methods will be vividly dramatized in a series of silent and talking motion pictures being produced by national industries in connection with A Century of Progress International Exposition to be held in Chicago in 1933.

The films will be loaned to schools, churches, clubs and other responsible organizations without cost.

Unusual and wonderful buildings of the Exposition will be shown, and thousands of interesting exhibits will be used to best interpret the progress of the past century. Thus in the first of the film series, a one reel picture showing advancement in the food industry, will be shown. Life in old Fort Dearborn, Chicago's early fortress, in the beginning of the nineteenth century, also will be shown.

Incidents of fort life, such as preparation of basic foods, trading with friendly Indians, and activities of the soldiers will be photographed with particular care given to reproduction of historic details as they actually existed one hundred years ago. History will repeat itself under the vigilant eye of the motion picture camera.

Then will follow the many steps in food manufacture that led to the modern and scientific methods now used. So it will be with films to follow in the series. Dramatic episodes will portray progress and achievement in numerous industries, from food to furniture.

The amazing contrast between the old and the new will be shown, vividly and colorfully, and the progress that no other century in the history of mankind has witnessed will be recorded for the benefit of the many thousand educational and civic institutions in all parts of the United States and also in other parts of the world. These films may be had by merely addressing the producers—Atlas Educational Film Co. of Oak Park, Illinois. A unique feature of this series is that films will be available in both silent and sound editions in both 16mm and 35mm sizes.

THE DEFICIENCY IN MATHEMATICAL TRAINING REQUIRED OF GEOLOGISTS

By H. W. Straley, III, *University of Chicago*

The science of geology was, in its incipiency, simply an adjunct to the business of mining. This quite naturally followed from the pressing need of the mining man to know more of the nature of mineral deposits. In collecting this material much data wholly unconnected with "commercial geology" was of necessity accumulated. Thus, in the early days of the science, many of the geologists were engineers by training, some of them skillful mathematicians and physicists. This state of affairs led to an application of mathematical and physical laws to the solution of geologic problems.

Of late years, however, there seems to have developed a distaste for quantitative applications along these lines. To the writer it seems that the pendulum has swung too far in a direction opposed to mathematical training, especially is this the case now that geology is approaching the quantitative stage.

In order to determine the amount of mathematical preparation required of students of geology, the writer consulted the catalogues of more than one hundred representative American colleges. The following table indicates the result of this investigation. Of the catalogues studied, the majority were entirely too vague and indefinite in listing their prerequisites to be of any value. However, the results of the examination of the twenty-seven catalogues used would indicate that relatively little emphasis is placed on preparation outside the field of geology itself. Schools or departments of mines of the various institutions are not considered in this table. It is well known that they require thorough training in mathematics and physics. It is worth mentioning that at the Canadian schools listed, the majority of the geology majors are taking their work in engineering, with a major in the subject of geology. Hence, the average is really higher for that institution than would appear from the table.

Mathematics Required	*No. of Colleges*
No mathematics above the eighth grade[1]	8

[1] Students are permitted to enter one University without having had more than the grade school course in arithmetic, but are required to take a minimum of five semester hours of mathematics in college. Courses in algebra, plane geometry, etc., are given college credit.

Elementary Algebra[2]	19
Plane Geometry	17
Intermediate Algebra	13
Solid geometry	5
Descriptive geometry	0
Drafting	3
Trigonometry	7
College Algebra	6
Analytic Geometry	5
Calculus[3, 4]	2
Mechanics[4]	1

Physics Required

No physics	13
Entrance Physics	1
Elementary College Physics	11
Engineering Physics	2
Surveying[5]	2

Chemistry Required

No Chemistry[6]	11
Entrance Chemistry	2

The following table shows the geographical distribution of the educational institutions included in this survey:

Geographical Section	*Number of Schools*
Pacific Coast	3
Southwest	4
Middle West	6
South	9
East	4
Canada	1
Total	27

A few years ago, from one of these institutions requiring a year of chemistry and physics for graduation, a young man received the Bachelor of Science Degree without either. Later he entered a technical university for graduate work, where he was required to take freshman courses because of deficiencies in what this university considered the fundamentals of the science.

[2] Plane geometry, elementary analysis, and one-half year of college physics are required for petroleum geology alone.

[3] One requirement specifies analytic geometry and engineering physics, but does not mention calculus, which is listed as one of the prerequisites of engineering physics.

[4] In one case calculus and mechanics are required for a major in seismology and physics, but neither is required for a major solely in seismology.

[5] One University allows graduate credit for surveying, but does not place it among the graduation requirements.

[6] One University requires entrance chemistry for a major in mineralogy, but not in geology.

Of course, it will be proposed that the subjects listed above are minimum requirements, and that students who are interested will secure the necessary courses in their late undergraduate or graduate years. This contention is fallacious in the case of the undergraduate, at least. He is urged by his councilors to take as much work as possible in his major study in order to prepare himself for a field position or for research. The graduate, because of financial circumstances, is usually compelled to complete his work as rapidly as possible. Hence, it is a hardship on him to have to take non-credit courses along with his more advanced geologic work. He is often unable to do so and must be content with a limited knowledge of his field because of insufficient mathematical training during the first years of his academic work.

The writer grants that the above survey is necessarily limited, and that the catalogues found unserviceable might have changed the results. It is, he believes, however, of the right order of magnitude. Without doubt the average requirement for a major in geology is higher than elementary algebra and plane geometry. This table indicates, on the other hand, that the mathematical training required for advanced study in the science of geology is deplorably deficient.

POCKET SIZE FOOT-CANDLE METER

Many simplified and new photocell applications with relays and indicating instruments have been made possible through the use of the new Weston PHOTRONIC Photoelectric Cell.

The latest of these applications, by the Weston Electrical Instrument Corporation, is a pocket-size Foot-candle Meter, built especially for salesmen's use, calibrated to read directly on three ranges; 50, 250 or 500 Foot-Candles.

One Cell is used as an adjustable Light Collector, with readings appearing on a scale 2.36 inches in length. The Cell and instrument are housed in a neat, black, moulded case, measuring approximately 3⅜ x 7 x 2¼ inches. A hinged cover and convenient carrying handle finish it in very attractive form.

BACK NUMBERS

Back numbers of SCHOOL SCIENCE AND MATHEMATICS can be supplied by our Business Manager except a few issues, but some issues are very rare and difficult to obtain. Back numbers cost 40 cents and up depending upon the number available. Write for quotation on single issues, volumes, or complete sets.

THE INSPIRATION WHICH THE JUNIOR ACADEMY OF SCIENCE HAS BROUGHT TO THE HIGH SCHOOL SCIENCE CLUBS IN THE STATE OF ILLINOIS[1]

By Louis A. Astell
Adviser, Illinois Junior Academy of Science

Four phases of this subject are to be considered here: first, the inspirational aspects of the history of the movement in Illinois; second, the principles which have been evolved and which may be counted upon to further enthusiasm among the sponsors and club members; third, certain personal results not already implied; and finally, the future of that Academy and its relations to the other academies.

I. INSPIRATIONAL HISTORY

From the viewpoint of history, as some of you know, the work in Illinois began in 1919. Mr. J. L. Pricer was secretary of the Senior Academy at the time. His annual report[2] at the Jacksonville meeting included the recommendation that there be "a permanent committee of three on science education in the secondary schools." A nucleus of four high school science clubs was affiliated during that year. Of these clubs, the Danville Science Club, according to the records, is still affiliated. Over the country as a whole, science clubs may be found that have been in existence for 30 or more years, but as science clubs go, with changes in sponsorship as perhaps the greatest hazard of all, this record of a twelve-year affiliation is worthy of emulation. Science clubs can be kept alive from year to year through the inspirational incentives of a Junior Academy of Science.

In the ten-year period which began in 1919, the State Committee met with obstacles. At least twice in that decade, special efforts were made to keep the organization alive. First, there was a printed pamphlet and then a form letter. This information was sent to all recognized and accredited high schools in the State. Neither of these plans, qualitatively or quantitatively, were exactly what was needed. The affiliations gained in

[1] Condensed from paper presented in the first annual program of the Indiana Junior Academy of Science at Butler University, Indianapolis, Indiana, December 5, 1931. It is anticipated that a condensed version will appear in Volume 41 of the Proceedings of the Indiana Academy of Science for the academic year 1931-1932.

[2] Pricer, J. L., Secretary's Report in the *Transactions of the Illinois State Academy of Science*, Volume XII, page 17, 1919.

one season were lost in the next, if not in the same season. An account of three of those clubs is briefly related in order that you may see some of the benefits a sponsor may obtain from this work.

As a beginning teacher, I organized and affiliated my first science club, of some 60 or 70 members, along the lines suggested by the pamphlet. The rôle of the pamphlet in this critical period of the movement, reminds me of that proverb from the ancient Sanskrit to the effect that, he who causes a thing to be done is the real doer of it. Doctor Hessler's committee prepared the pamphlet. To me it was Doctor Hessler's committee that stood as the immediate inspiration for this club and those that followed. The next year when I went back into professional training, the new science teacher succeeding me would have nothing to do with the club. Toward the end of the year, however, the president of the club wrote to me and said that the club unaided had purchased a piano for the school from the proceeds of a benefit program. The boy added his regrets that so little more had been done.

If an affiliated club can do that much without a sponsor, it seemed to me that at least a sponsor should be able to remove the apologies and regrets from the minds of those club members; should be able to make those club members feel and enjoy the success they earned. Such action on the part of sponsors seems very important, psychologically. Certainly, there are other kinds of tangible success for school boys and girls than are to be found in the athletic field or on the gymnasium floor.

In due time, and in another school, I organized and affiliated the second science club. This club held its initiations on one of the neighboring and highest bluffs in the State. It adopted a club pin. It purchased a motion picture machine for the school, and gave programs for the membership, for the school, and for some of the civic organizations in the community. Again the science teacher chosen as my successor was uninterested in the welfare of the science club and this second club followed in the disasterous wake of the first.

In the third school of the sponsor's experience, and for the third time, a science club was organized and affiliated. Science clubs seemed indispensible to him. Science seemed indispensible to the welfare of his clubs. This time the club was some

larger than either of the predecessors. There were perfections in detail at all points. A definite program of objectives was developed which reached out into the interests of the community. The club came to have a significant meaning to the members, to the school, and to the community through these activities and through the participation of its members in the annual meetings of the Junior Academy.

This time, contrary to the preceding cases, when his successor was to be chosen one of the requirements imposed by the superintendent of schools was that the new teacher be qualified and ready to continue the work of the club. That club is now in the second year of its healthy, desirable activity following the change of sponsors. The two other clubs became inactive in much less time, due to a failure on the part of science teachers, and due to a failure on the sponsor's part in demonstrating the importance of the work to the administrators.

It was during the early organization period of this third club that I was invited to give a paper before the Section of High School Science and Clubs at the annual meeting of the Academy. Naturally enough, I chose a title involving the affiliation of science clubs.[3] The title, as printed in the program, caught the attention of a couple of science club members in a non-affiliated club of the city in which the paper was presented. These members came to take notes. Among the dozen or so teachers, who comprised the remainder of the audience, was Miss S. Aleta McEvoy of Rockford, Illinois.

The following year, at the Bloomington meeting, Miss McEvoy was made chairman of the section. Upon her suggestion, the "Illinois Junior Academy of Science," as we now know the affiliated group of high school science clubs, was christened. Emphasis was shifted from the problems of the teacher to those of the student club members. In the first year of her chairmanship, 3 new clubs were added to the roster. The following year there were 22 new clubs, and last year there were 24 more. The number of student delegates attending the annual meeting has kept pace with this growth. These statements may be taken as a general index to the inspiration which the Junior Academy affords the high school science clubs in Illinois.

For the committee in charge of the Junior Academy, it may

[3] Astell, L. A., "A Ritual and Other Devices for High School Science Clubs," SCHOOL SCIENCE AND MATHEMATICS, 27:952-55 (Dec., '27).

be said that there are two chairmen, ordinarily; one for the High School Sciences, and one for the Junior Academy embracing the high school clubs. These chairmen have a joint relationship to the remainder of the committee.[4] Thus, a compact committee of five including one college representative has served our needs very well up to the present time. It is a personal opinion, however, that if the annual competition expands much farther, there will be a need for an additional college representative or for another sponsor of an affiliated club. This additional member should be from the city in which the annual meeting is held.

The Illinois Junior Academy of Science is no longer an organism of perplexing constitution and health. Its present status is merely another reward for patience and perseverance; and another tribute to science as a body of knowledge which, in some respects at least, can be as inspiring as that for any other form of human endeavor.

II. INSPIRATIONAL PRINCIPLES

In turning to the principles upon which the Junior Academy has been guided, it seems to me that there is no need of a justification for the existence of the organization as long as we have so many other high school activities on a state and national basis. Among such organizations, I have in mind; athletics, music, journalism, 4-H, and most recently, the national "organization of student-body presidents" with a proposed department in the National Education Association.[5] If it is true as has been said, that the educational literature points to assumed rather than to established values for extra-curricular activities,[6] it may also be said that any determination of values with reference to science club work as one of these activities would be of historical rather than of guiding significance here in the middle west, because science club work in this area is rapidly assuming a new relative position with reference to other extra-curricular activities. The point is worth making

[4] The membership of this Committee for the current year is: Chairman, Miss Mable Spencer, Granite City Community High School; Mr. Paul Houdek, Robinson High School; Miss S. Aleta McEvoy, Rockford Senior High School; Doctor Lyell J. Thomas, University of Illinois; Mr. Thomas H. Wilson, Arlington Heights High School; L. A. Astell, Advisory member. Due to Miss McEvoy's illness, Miss Spencer has complete charge of the Junior Academy activities.

[5] *Journal of the National Education Association*, 20:344 (Dec., 1931).

[6] Houston, G. D., "Extra-curriculum activities in their true light," *Education*, 50:282-92 (Jan., 1930).

since a recent survey[7] involving some 1288 high schools in Idaho, Montana, Oregon, and Washington, shows that there is less administrative endorsement for subject-centered clubs, as conducted at present, than for other types of clubs. Were there Junior Academy organizations in those western states, administrative opinion with specific reference to science clubs might conceivably be much different than it now is. Beyond the matter of administrative opinions, the extra-curricular authorities[8] generally appear to favor most the club work, which grows out of the classroom and there is no inconsiderable number of teachers, who agree with Miss Pierce of Atlanta, Georgia, that one of our most important tasks is "to make the mentally brightest pupils in school, the most attractive, the most popular, and the most useful."[9]

The outstanding principle, then, whether in the local or in the state activities of the affiliated clubs, is that the student members shall actually participate in the various phases of the work; that the organization shall exist primarily for the benefit of these members; that as in classroom work, the sponsors shall derive their personal inspirations through the benefits obtained by their students. This thought ultimately leads to the idea so aptly expressed by Whitman, when he said in effect that "He most honors my style, who learns under it how to destroy his teacher."

So it is that the Illinois Junior Academy of Science has a group of honorary state officers made up of club-member delegates from over the state. At the time of the annual meeting, these honorary officers perform the official induction ceremony[10] for the new clubs. These new clubs are represented by their own delegates in the ceremony. The major fields of science are considered in these annual programs. If an enthusiastic chemist gives the feature lecture, as did Dr. B. S. Hopkins at the Macomb meeting,[11] then another field of science is represented by the feature lecture the following year. We have found that one such feature lecture is sufficient for this audience.

---

[7] Russell, R. D., "What benefits do pupils derive from school clubs," *Nation's Schools*, 7:35-40 (March, 1931).

[8] Fretwell, E. K., "The place of extra-curricular activities in education," *School and Society*, 21:635-39 (March 14, 1925).

[9] Pierce, L., "Our Chrysalis Club," *School and Society*, 34:231-32, (Aug. 15, 1931).

[10] Astell, L. A., "Initiation ceremony of the Edisonian Science Club," *School Science and Mathematics*, 28:771-74 (Oct., 1928).

[11] Hopkins, B. S., "Opportunities in Science," *Transactions of the Illinois State Academy of Science*, 22:623-29 (May 3 and 4, 1929).

In addition to the ceremony and the lecture, there is usually an excellent scientific film, and a roll call of the various clubs responded to by a brief statement of the outstanding activity in which each specific club is engaged. The remainder of the morning is spent in examining the entries prepared and entered by the clubs as organizations and by the club members as individuals. This annual competition embraces posters, exhibits, and other projects.

Beginning this year, the awards for this annual competition are to be of the diploma type and will bear the signatures of the academy officials. The engraved form will be the same for all events and places. This plan will make possible a greater variety of events, will give students an initial, inspiring contact of a permanent nature with the state leaders in science, and will mean a substantial saving in expense. Through the savings thus brought about, the printed magazine can be continued. It is hoped and planned that the annual issues of the magazine may be increased in number as the Junior Academy grows in order that all affiliated clubs may have an adequate voice in it.

No organization is more secure than its financial bases. For this reason, it seems that there should be some explanation of how, financially, both ends are made to meet. Our credited income depends on the following sources:

1. Entrance and annual dues of clubs, sponsors, and others, obtained through the efforts of the Junior Academy officials and club sponsors.
2. Commission on state-wide adoption of pins worn by students in all affiliated clubs.
3. Advertising in the printed magazine.
4. Annual contest entry fees.

It is true that the senior organization has made cash contributions and loans in the past, but it is not the policy of the Junior organization to be a financial parasite. Worth-while organizations should not have to be dependent. Financial independence of student organizations can be an important consideration in the training of these same students. In the first year of the present program of the Junior Academy, the receipts balanced the expenditures within five dollars. Every letter in the follow-up campaign was filled to the limit of postal regulations. These letters were signed but the salutations were to administrators and to science teachers in general, rather than to these individuals personally. Letters of this sort, unsealed, went for a cent and a half rather than for two cents. They were ef-

fective, because the envelopes were addressed to the individuals by name, because the series was timed and reached a climax in point of interest approximately two weeks before the annual meeting, and finally because personal requests for information resulting from the form series were answered personally. Donations in the form of stenographic service and materials were in-order then as they are today. Through such careful planning many things can be accomplished for a relatively small amount of money.

During the past year, some financial mistakes were made, but it is thought that the remainder of these mistakes was corrected at the last business meeting. One of these mistakes concerned the magazine, which was published without advertising. The supposition was that the local club sales of copies would cover the cost. This theory might be true for a greater number of affiliated clubs, or for a more adequate meeting of other factors, but it did not prove true for the number of clubs we had at the time. In all fairness, it should be said that the magazine was assembled in less than two weeks in order to be available at Holiday time.

The method of handling monies is another matter worthy of attention. All receipts from the four sources referred to above pass through the hands of the senior organization's secretary and treasurer. Likewise, the disbursements are made by the Senior Academy on authorized expenditure accounts, except for items of less than five dollars. This relieves the Junior Academy of auditing, and assures all concerned that there is no possible chance for misappropriation or other difficulty.

The method of handling the orders for pins will serve to illustrate the point. The local sponsors collect the money from their club members. While still holding the money, these sponsors place their orders with the designated Junior Academy official. This officer prepares the order blank in quadruplicate. The original is sent directly to the manufacturing jeweler, who prepares the order and ships it C.O.D. to the sponsor of the local club. The second is sent to the treasurer of the Senior Academy, the third copy is sent to the secretary of the senior organization, and the fourth copy is retained by the Junior Academy official. At stated intervals, the manufacturing jeweler forwards the refunded commission directly to the treasurer of the Senior Academy. At no time in the transaction has any

of this money passed through the hands of the Junior organization's officials, yet it is possible for these officials to know what their accumulated credit is at any time.

III. PERSONAL RESULTS NOT IMPLIED

Up to this point certain aspects of the history and of the principles, together with the general results incidental to these two phases of the problem, have been considered. There are other results reaching down into the lives and activities of the boys and girls, who wear the Junior Academy pins in Illinois. I shall mention a specific case.

The sponsor of one of the affiliated clubs found a boy member making a day-by-day clipping record of Byrd's South Pole Expedition and as a result built a "Pole to Pole" program around a half-hour talk by this gifted student. The program was presented while Byrd and his men were battling the ice pack. The boy's talk was on, "Commander Byrd, His Life and Achievements." Parents of all club members were invited. The boy's talk brought out many things, but most important of all points was an open allegiance to his ideal among the daring and generous leaders of men. Naturally, the boy was one of the delegates to the annual meeting where he had an opportunity to hear Doctor Griffith Taylor's illustrated lecture, "With Scott in Antarctica." The boy's enthusiasm could not be stated mildly. Here before him was the tramping ground of his own Commander Byrd; here another comrade of the icy wastes. While the boy was attending the University of Wisconsin as a freshman last year, Byrd came to Madison on his lecture tour. The boy must have been keeping an hour-by hour record of his hero then. At any rate his desire to talk to Byrd personally, to know Byrd as Byrd's own colleagues had known him, became an overpowering influence. Byrd was a guest of the Governor at the moment. Without an invitation, the boy gained admission at the Governor's mansion to stand speechless from emotion in the presence of Byrd and others in attendance. Both Byrd and the Governor sensed the situation and put the boy at ease. That evening the boy sat with the Governor's party in the lecture hall. That evening a far-away dream of one more aggressive American boy was fulfilled.

Different emphases might be placed on the incident, but is it not true that what this boy did in the face of social custom for

the sublimation of his interests, represents essentially what a scientist does in the face of accepted thinking to give a fundamental discovery to the world? Boys and girls, as you sit here today, I trust that your Junior Academy at some time and in some way may help to drive you as this boy was driven, beyond the matters of every-day existence to the infinitely important and numerous quests that shall have a profound meaning for your fellowmen. To be a personal leader and to be so driven will be a lasting reward to your sponsors and a challenge to your associates.

IV. INSPIRATIONAL FUTURE

Concerning the inspirational future, it may be said that the Indiana Academy of Science, in making provisions for a Junior Academy, has done what several other State Academies have done or are preparing to do. These states lie in a more or less arc-like area through the United States. Beginning at the eastward, these Academies are: North Carolina, West Virginia, Ohio, Indiana, Kentucky, Tennessee, Illinois, Iowa, Kansas, Oklahoma, and Texas.

The decade of experimental effort in Illinois has resulted in a three-year demonstration of enthusiastic response from the affiliated clubs. It has given us a few principles born of experience, and it has given a total of results beyond the expectations of those of us, who have worked longest and hardest over the idea.

For the two years just past, the Conference of State Academies of Science has officially considered the development of the Junior Academy movement.[12] Under Dr. Otis W. Caldwell, Chairman of the Committee on the Place of Science in Education, American Association for the Advancement of Science, last year, I was directed to render every possible service to the Junior Academy in Illinois and in other states as a part of my regular duties. Under the able guidance of such distinguished educators, we may be assured that in so far as this work merits support, such support will be found, just as support for the Junior Academy as a state organization in Illinois has been found, and just as now support for your organization here in Indiana is being found.

From the inherent nature of the Academy organizations,

[12] Astell, L. A., "How State Academies of Science May Encourage Scientific Endeavor Among High School Students," *Science*, 71, No. 1844, 445-49 (May 2, 1930).

however, we may expect for the immediate future that the great contributions of the Junior Academies will be within, rather than beyond, their respective state jurisdictions. For those of us who are furthering this work, it may be said that we are finding in it an opportunity to express our continued appreciation for the inspirations that continue to come to us.

EXPERIMENTS IN ALLOTROPY. II. OXYGEN AND PHOSPHORUS ALLOTROPES

By Eugene W. Blank
241 N. Ninth St., Allentown, Pennsylvania

OXYGEN AND OZONE

As early as 1775 M. van Marum noticed a peculiar odor in the neighborhood of electrical machines in motion. In 1840 Schonbein[1] proved the odor was due to the formation of a gas containing three atoms of oxygen to the molecule. Ozone is therefore represented by the formula O_3, and its formation from ordinary oxygen is represented by the equation:

$$3O_2 \rightarrow 2O_3.$$

Ozone is an allotropic modification of oxygen distinguished by its great chemical activity. It is a vigorous oxidizing agent, yielding up a third of its oxygen and leaving a molecule of ordinary oxygen.

The presence of ozone can be shown by means of a strip of filter paper wetted with a solution of starch and potassium iodide. The paper becomes blue in the presence of ozone due to the liberation of iodine.[2]

The usual method of preparing ozone is to expose a stream of air or oxygen to the silent electrical discharge. An ozone generator can be readily constructed of a common glass condenser. The central tube of the condenser is filled with dilute sulphuric acid to serve as one of the electrodes. The other electrode consists of tinfoil wrapped around the outside of the condenser. A half-inch spark coil is sufficient to produce appreciable quantities of ozone. Air aspirated through the ap-

[1] A very interesting account of the life and researches of Schonbein on ozone is given by R. E. Oesper, J. Chem. Ed., 6, 432-40; 6, 677-85 (1929).

[2] Benoist, Compt. rend., 168, 612 (1919), advocates an alkaline solution of fluorescein as a delicate reagent for ozone. In the presence of ozone the green fluorescein color is destroyed.

paratus will contain 2 to 8 parts per hundred of ozone. A piece of starch-iodide test paper placed at the exit of the tube will immediately be colored blue.

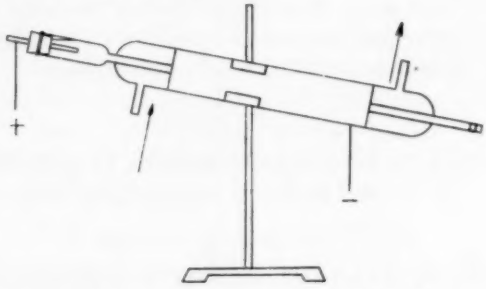


FIG. 1. Ozone apparatus constructed of a glass condenser. The inner tube filled with sodium chloride solution serves as one electrode the other being a layer of tinfoil on the outside surface. Air to be ozonized is aspirated through the water jacket.

Ozone has a remarkable effect on mercury. If some ozonized air be admitted into a flask containing mercury the latter becomes dull in luster and spreads a film over the interior of the flask. By adding water the mercury recovers its luster. This is a most characteristic effect and the reaction is so delicate a very small bubble of oxygen containing only 1/50 of its bulk of ozone will destroy the luster of several pounds of mercury and cause the latter to lose its customary mobility and convexity.

YELLOW AND RED PHOSPHORUS

Phosphorus exists in two well known allotropic modifications commonly called yellow and red phosphorus. The former is a translucent, colorless solid that readily catches fire from the heat generated by its slow oxidation when exposed to the air. When yellow phosphorus is heated to about 250°C. in an inert atmosphere it is converted into a chocolate colored powder known as red phosphorus. It is insoluble in carbon disulphide and other solvents that readily dissolve the yellow form and ignites only when strongly heated.

The conversion of yellow phosphorus into the red modification can be readily demonstrated by sealing some of the former into a small tube and heating in boiling diphenylamine. The yellow phosphorus should be cut into thin slivers under water

and packed in a small stoppered vial such as is commonly used for containing the sample in a determination of molecular weight by the Victor Meyer method. Fasten the stopper with a thin copper wire. Place the filled vial inside of a glass tube sealed at one end and arrange an apparatus as shown in Figure 2. Diphenylamine is placed in the flask and brought to the boiling point (310°C.). The yellow phosphorus is soon converted into the red variety. The speed of the transformation is greatly accelerated by the presence of a trace of iodine.

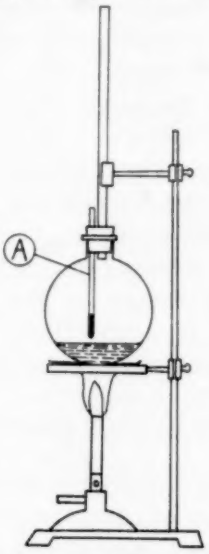


FIG. 2. Arrangement of apparatus to demonstrate the change of yellow phosphorus to the red variety. A small vial filled with yellow phosphorus is placed in tube (A).

LITERATURE CONSULTED

1. Mellor, *Comprehensive Treatise on Inorganic and Theoretical Chemistry*, Vol. I. New York City: Longmans, Green and Co., 1922.
2. Senter, *Textbook of Inorganic Chemistry*. London: Methuen and Co., 1916.

HAVE YOU CHANGED YOUR ADDRESS?

Every fall a number of complaints are made because the October number has not arrived. Many of these are due to failure to notify our Business Manager of the changes of address. If you have moved since June write your new address and your old one on a post card and mail it to SCHOOL SCIENCE AND MATHEMATICS, 3319 N. Fourteenth Street, Milwaukee, Wis.

A WISCONSIN PHILOSOPHY OF SCIENCE TEACHING

*Committee of the State Teachers Association**

NEED FOR A PHILOSOPHY

To be successful, a science teacher should possess a comprehensive understanding of the field of science and an intensified knowledge of his particular teaching field. He should also understand how children learn. But this knowledge and understanding will not make him an effective teacher unless he is guided in his thinking and teaching by a consistent educational philosophy. He gradually acquires this philosophy as a result of the crystallization of his educational thinking and the experiences of himself and others. It gives reason and purpose to his teaching procedures. One's educational philosophy must not be changed by every passing fad but must be held to until improved by experimentally validated revisions. The revisions made from time to time should keep the philosophy constantly attuned to changing conditions, so that the teacher may fit pupils for participation in a scientifically improving civilization. While this philosophy should be put in writing in order to stimulate specific thinking, it should be not an end in itself but a means of promoting educational growth.

WISCONSIN PROGRAM OF EDUCATION

The general philosophy of education formulated by the Wisconsin Teachers Training Council (Wisconsin Journal of Education, Jan. 1932) recognizes education as "growth through problem solving" so that the individual will act "in such a way that he will make the greatest possible contribution to society and at the same time receive the greatest possible personal satisfaction." Toward the accomplishment of this general program science can make specific contributions.

GENERAL OBJECTIVES OF SCIENCE TEACHING

The purpose of science, as of any subject, is to develop ability in the individual to solve the problems that confront him. To

* Members of Wisconsin State Science Committee: J. H. Baker, Principal of High School, Sharon; E. H. Boettcher, Principal of High School, Elmwood; Fay Coon, Teacher of Biology and Supervisor of Nature Study, West Allis; A. T. Rogers, Professor of Chemistry and Educational Methods, State Teachers College, Stevens Point; Geo. J. Skewes, Teacher of Chemistry and General Science, Wisconsin High School, Madison; Chairman, Ira C. Davis, Assistant Professor in the Teaching of Science, University of Wisconsin, Madison.

solve these problems he will need (1) an attitude which will lead him to recognize and attack problems; (2) a scientific method of procedure which will be more efficient than a "hit and miss" trial and error method; and (3) a fund of information which will make it unnecessary for him to repeat the experimentation which has produced our present civilization.

FUTILITY OF RANKING

The attempts of teachers in recent years to rank the objectives of science have been misleading. For meeting the problems of life the individual needs scientific information, he needs a scientific attitude, and he needs a scientific method of attack. Attempted ranking of such essentials is as futile as attempting to decide whether a man's heart or head is more important for his physical existence. None of these objectives is an end in itself and no one objective would be of much value to an individual, but taken together they are the elements that make progress possible. The science teacher, then, should attempt to develop these essentials simultaneously, and at the same time to cultivate in the pupil an interest in and an appreciation for science which will motivate him to make further scientific endeavors after he has left school.

SPECIFIC OBJECTIVES

In listing the specific objectives of science teaching no attempt is made to classify them under the general categories of information, attitudes, methods, interest, etc., because there is no commonly accepted line of demarcation between such categories. Freedom from superstition, for instance, is the result of a combination of a scientific attitude and scientific information. With no implication as to their relative importance the following are suggested as some of the specific aims or objectives of science teaching:

1. *Command of factual information.*—Science courses should give the individual such factual information as he will be able to utilize in solving his scientific problems. If he does not possess or know where to obtain the factual information which others have made available, much of his time and energy will be dissipated in re-discovering such facts for himself.

2. *Familiarity with laws, principles, and theories.*—The science trained boy or girl should be familiar with the principles, laws, and theories of science. These generalizations and hy-

potheses, like factual information, are of inestimable value in solving problems.

3. *Power to distinguish between fact and theory.*—Science should train the individual to distinguish clearly between fact and theory. Theories have been valuable aids in solving problems and in helping to explain phenomena but they do not possess the same validity as facts.

4. *Concept of cause and effect relationships.*—Science should develop a concept of cause and effect relationships. Science is rich in possibilities for showing the inevitable linking of effect to cause. When the cause is not known the scientist is interested in finding it.

5. *Ability to make observations.*—Science should teach the individual to determine the truth in controversial matters by means of his own observations rather than to accept as authoritative the opinions of others. It should also assist him to become familiar with common phenomena by means of his own observations. The use of proper instruments for assisting in such observations should be encouraged.

6. *Habit of basing judgment on fact.*—Science should train the individual to base judgments on fact and not on prejudice or opinion. This implies suspending judgment until evidence is reasonably complete.

7. *Ability to formulate workable hypotheses.*—Science should train the individual to form hypotheses on the basis of available evidence when complete evidence is unavailable. Such "scientific guesses" make for more efficient problem solving by systematizing the trial and error method.

8. *Willingness to change opinion on basis of new evidence.*—Science should make the individual open-minded: willing to change his opinion in the light of new evidence. Opinions, theories, and hypotheses should be constantly revised to keep them in accord with all available evidence.

9. *Freedom from superstitions.*—Science training should eliminate superstitions by supplying the open-minded individual with the evidence and information which will make such beliefs untenable.

10. *Appreciation of the contributions of science to our civilization.*—Science teaching should assist the individual to understand and appreciate the contributions science has made to our present civilization.

11. *Appreciation of natural beauty.*—Science should help the individual appreciate the natural beauty of his environment by increasing his powers of observation and by acquainting him with the marvels of the life and objects around him.

12. *Appreciation of man's place in the universe.*—Science should give the individual an appreciation of man's place in the whole scheme of the universe through information concerning astronomical relationships and physical forces as well as through information concerning the earth and its plant and animal life.

13. *Appreciation of possible future developments of science.*—Science training should give the individual a vision of the future possibilities of scientific contributions to human welfare. It should make him realize that problems now considered insolvable may be solved. It should make him realize the limitations of present scientific knowledge. It should also make him realize that in a social situation science may be only one of the contributing factors.

14. *Possession of interest in science.*—The individual who has been exposed to one or more science courses should possess an interest in science which is the result of personal achievement and which will be a motive force for further scientific endeavors.

This list does not exhaust the possibilities of science. Science teaching may be as effective as other subjects for teaching morality, citizenship, habits of thinking and habits of work, but it does not have exclusive claims in these fields.

The science teacher realizes that some of these objectives contribute to vocational efficiency, some to social efficiency, some to health, and some to the worthy use of leisure time. Moreover, he realizes that sometimes a given unit or subject may be vocational for one individual while for his neighbor in the next seat this same material will be cultural with no vocational applications. The teacher realizing this does not demand identical activities from all pupils but permits variation in the type as well as in the extent of work accomplished.

PUTTING THIS PHILOSOPHY INTO PRACTICE

Such a philosophy of science demands a re-evaluation of existing curricula. Courses may need to be revised or new ones offered in order to make possible the realization of the accepted

objectives. The science teacher should be scientifically critical of his subject offerings and teaching procedures to the end that each pupil may experience such growth as will enable him to "act as wisely as possible in the social groups of which he is or may become a member."

MEASURING RESULTS

It is desirable that science teachers be able to ascertain the extent to which their offerings are producing the desired pupil growth. To do this some intelligent plan of measurement is needed. But educational growth is a complex affair which cannot be measured by a single instrument or test. It is difficult to measure knowledge accurately but much more difficult to measure such things as scientific attitude and scientific method. Of the specific objectives listed only those depending directly upon information have been measured with any degree of accuracy or validity. Science teachers need means for measuring the extent to which each of the specific objectives is being realized. Co-operative experimentation is needed for evolving such measures.

FURTHER EXPERIMENTATION NEEDED

Research is needed to determine the best grade and age placement of various subject materials and the best time to initiate a program for realizing each objective. Additional research is needed to determine the best teaching methods for realizing each of the objectives at the various ages. On the basis of this experimental evidence it may be possible and advisable to offer an integrated, continuous program of science from the kindergarten to the university.

RADIO LAYER CAUSED BY LIGHT ECLIPSE TESTS INDICATE

The radio reflecting layer of the earth's atmosphere that is about sixty miles above our heads is caused by radiation from the sun traveling with the speed of light. This tentative verdict, announced by Dr. Lyman J. Briggs, acting director of the U. S. Bureau of Standards, comes as the result of extensive radio tests during the eclipse in August.

A rival theory advanced by British scientists attributed the formation of the ionized reflecting layer to particles shot out from the sun with much less speed than light. The Bureau of Standards results uphold the idea that ultraviolet light and not solar particles are responsible.

The critical frequency of the E or lower region of the Kennelly-Heaviside layer decreased approximately a thousand kilocycles during the eclipse, lagging behind phases of the eclipse by approximately five minutes. After return to normal no later effects were observed.

—*Science Service*

A DEVICE TO SHOW THE RETROGRESSION OF THE PLANETS

By Luise Lange
Crane Junior College, Chicago

In the following I am going to describe a little self-made astronomical model which I have found very useful and effective to demontrate one of the central points of the Copernican doctrine: how the combined motion of the earth and the planets around the sun brings about the observed periodic retrogressions of the planets. The idea of the model in itself is in no way original, it is indeed almost obvious. But the great simplicity of its execution and the universal and immediate availability of the material used justify, I believe, its being presented at this place. Moreover the new interest in the motions of the heavenly bodies which the Adler planetarium in Chicago is arousing in thousands of people may be said to impart a new actuality to this old problem.

In any clock the two hands travel about the center with their angular velocities in the ratio 12:1. This suggests that they might be used to represent the respective motions of the earth and the planet Jupiter, the former traveling in one year, the latter in only a little less than twelve years around the sun. However, in the case of the clock it is the large hand which travels twelve times *faster* whereas in the case of the planets the outer one, Jupiter, is the one to travel twelve times *slower* than the inner one. Accordingly the small, slow hand of the clock has to be made the longer of the two, indeed about five times as long as the fast hand, Jupiter being a little over five times as far from the sun as is the earth.

With this idea in mind we took an old alarm clock and removed it from its metal case. Next we shortened the long hand by turning up its end, and extended the small hand by means of a piece of thick copper wire likewise with its sharpened end turned up. On these turned-up ends we placed two beads, a little one for the earth and a big one for Jupiter. Next we removed the regulator so that the clockwork, if released, will just run off, driving the fast hand around in about one second. However the speed of the motion can easily be regulated by placing a finger lightly against any conveniently located gear. On releasing the clockwork we see the two planets traveling around

with approximately correct relative velocities and distances, alternately drawing closer together and farther apart as they get on the same or on opposite sides of the sun. So far the model illustrates what we call the "true motion" of the two planets.

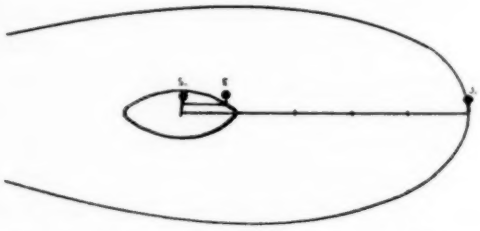


FIG. 1. "True Motion" of Earth and Jupiter

But now comes the more interesting point: the *apparent* motion of Jupiter as observed from the earth. The place in the heavens at which Jupiter is seen from the earth lies at every moment in the direction of the straight line between the two planets. The motion of this line as the two planets travel in their respective orbits constitutes Jupiter's apparent motion. To demonstrate this we made a pointer, about twelve inches long. (cut from the flattened out discarded case of the clock) and placed it over the two turned up ends of the hands, fitting it with a hole over the Jupiter-end, and with a long enough slot (about two and a half inches) over the earth-end to allow for their varying distance apart. Finally the bead planets were put back in their places.

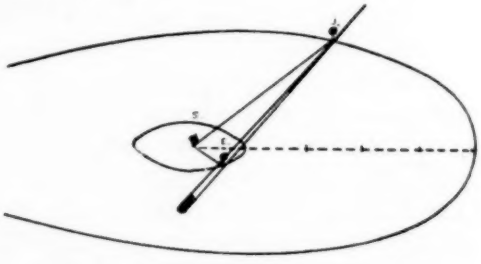


FIG. 2. Apparent Motion of Jupiter

Now we again set the universe in motion. As before the two planets travel uniformly arround the sun. But the pointer connecting them is now seen to move alternately onward and backward just as Jupiter appears to do in the heavens. Whenever

the earth comes near passing between the sun and Jupiter the pointer begins to gradually move backward, then on again, reaching its greasest forward speed when the two planets are on opposite sides of the sun. Because of the nearly correct ratios in the model this apparent motion of Jupiter is shown very approximately correct also in its *quantitative* aspects. To follow it up in this respect the dial of the clock may be used to great advantage. On it one reads not only the year (one full revolution of the earth) but by means of the division into twelve parts also the months, down indeed to a fifth of a month.* Writing the names of the months along the successive hours (e.g., beginning at 12:00 with March, the month of the spring equinox) any position of the earth now signifies a definite time of the year. To add further astronomical meaning one may also write the constellations of the zodiac diametrically opposite the respective months in which the sun is seen to pass through them, Virgo at 12:00 Libra at 1:00, etc. Watching now on the dial how often and where Jupiter appears to retrograde we easily read off: it retrogrades about every thirteen months; the retrograde arcs lie a little over 30° apart; e.g., if at one time Jupiter is in the middle of its retrogression during February in the constellation of Leo (as it was this year) the next year this happens in March in the constellation of Virgo, etc. One further reads that the retrogression from beginning to end lasts about four months, and that the retrograde arc is about 10° long. The model makes it clear that the time and arc distance between two successive retrogressions depends solely on the angular velocities of the two planets, whereas the duration and arc of any one retrogression depends in addition on their relative distances from the sun. This latter ratio our model would easily allow to vary, not however the relative velocities. Therefore it cannot quantitatively demonstrate the behavior of the other planets.

But with its moving line of sight between earth and Jupiter the model demonstrates just as well the motion of the earth as seen from Jupiter, which means the motion of an inner planet seen from an outer one. That is the kind of motion exhibited to us by Venus and Mercury. Watching the end of the

* The clock itself adds another little astronomical feature: the occasional rattling of the rudimentary alarm announces each time when Jupiter (the original small hand of the clock) has made a complete revolution, that is, it rings Jupiter's sidereal period.

pointer beyond the "earth" we see it moving periodically onward and backward, but always within a limited arc distance from the sun.

Finally one may use the model to demonstrate—though not in the best possible way—still another interesting point: that if two planets move concentrically around the sun either one moves relative to the other in an epicyclic curve, as had been maintained by the Ptolemaic theory. To show this we have simply to regard Jupiter as stationary, that is, refer the position of the sun and the earth to it as a fixed point. This can

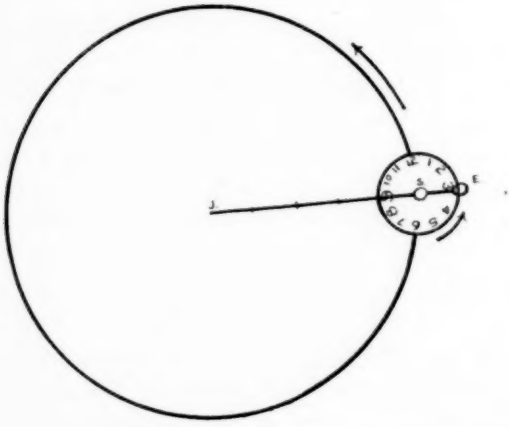


FIG. 3. Epicyclic Path of the Earth with Jupiter Stationary

be accomplished by concentrating the attention on Jupiter as point of reference. This effort can be effectively aided by guiding the model, while in motion, in such a way as to keep Jupiter in a fairly stationary position relative to the table beneath. With Jupiter's position fixed the sun is seen to move around it in a circle, and the earth, traveling in a circle around the sun, is seen to describe relative to Jupiter an epicyclic path. Jupiter, vice versa moves in that very same curve relative to the earth, namely in an epicyclic curve in which the center of the epicycle travels around the deferent in twelve years while Jupiter travels in the epicycle in one year. This was the way in which the Ptolemaic theory had described the motion of Jupiter. This last demonstration is therefore useful in bringing home the complete equivalence of the Ptolemaic and Copernican theory from the merely mathematical point of view.

THE DANCE OF ENERGY

By Sue Avis Blake
Bryn Mawr College, Bryn Mawr, Pennsylvania

With contagious rhythm, now in the guise of matter, now as radiation, energy swings to and fro to the Mock Turtle's tune "Will you, won't you, will you, won't you, will you join the dance?"

A heavy bridge may be set into vigorous vibration by the footfalls of a trotting horse or little dog, and soldiers marching over must break step. Objects about a room—gas-globes, the prisms of an old-fashioned chandelier, respond to a piano tone. Everything free to move has its own natural period of swing and may be played upon by the veriest tiny impulse if rightly timed. Each is an instrument—woodwind, reed, what-not. The ear, a stringed instrument, responds as a violin responds, with fibers in its basilar membrane, many thousands of them, taut and tuned. Energy in the guise of oscillating matter is the physical basis of sound. The range of audible sound is limited as the number of fibers in the basilar membrane is limited. The rumbling of low organ notes we feel rather than hear and to the higher bird notes and insect noises we are deaf.

To the dance that carries over from red to violet our eyes respond. Beyond on each side the dance continues although our eyes are blind to this. Out of an orchestration so vast as at least fifty-six octaves, ranging from radio waves to cosmic rays, we sense directly one octave. Intricate and varied are the symphonies our eyes must miss. Fifty-six octaves of sunset, what unseen splendor of a setting sun!

The full gamut of radiant energy holds together because of its many common characteristics. Indeed it is we who classify, speaking of heat and light and x-ray. Only frequency of pulsation increases in proportion as wave-length decreases, the product yielding always the value of that stupendous speed of light through space—one hundred eighty-six thousand, one hundred seventy-three miles per second, almost seven and a half times around the earth. Radio waves are listed with familiar frequencies of hundreds of kilocycles, meaning that they pulse this many thousand times each second; while matter to yield music beats from about sixteen times to thirty thousand times per second. Yet, for radiation, radio waves are as slow

comparatively as their wave-lengths are huge, and waves a mile or more in length shrink in cosmic rays to some million-millionths of a centimeter, which accompany frequencies of oscillation so vast that by no possible stretch of imagination may one conceive them. Such swiftness of pulsation cleaves a path before it while its momentum would carry it through eighteen or twenty feet of lead before complete absorption. Even in imagination we steer a middle course between the stars and atoms.

All incandescent solids, inclusive of the nuceleus of the sun, viewed through an analyzing prism, show a continuous rainbow band from red to violet. In a gas, however, since here the atoms are not crowded, they do not jostle and so may broadcast their own peculiarly characteristic tunes. The spectrum of a heated gas consists, therefore, of a limited number of colors. These are recurrent wherever and whenever the gas is observed. When in an atom an orbital electron, speaking in terms of the Bohr model of the atom, falls in towards the nuclear mass, from a higher to a lower energy level, the atom radiates giving a monochromatic color, that is, a color which cannot be further resolved. A monochromatic color is like a simple tone in music, it represents one definite frequency of vibration. The frequency of this emitted light is determined by the particular energy level bridged, each line of the spectrum indicating a separate level. The radiation of energy from a gas being thus discontinuous indicates the emission of little bundles of energy or "quanta." Dr. Millikan compares the emission of these quanta to the jerks of the hands of an electric clock which move only in response to orders at stated intervals. What constitutes orders in the case of an electron we do not know. But that the eye must have within a mechanism similar in dimensions as in kind to whatever gives rise to the spectrum between red and violet is necessary since to respond is to correspond.

Radiation pitched high for the eye's response a photographic plate may detect and beyond, where photographic plate also is blind, a fluorescent screen may discover x-rays and gamma rays; an electroscope these and cosmic rays as well. What, on the other hand, is pitched low for the eye, may be felt as heat or detected by the radio tube. To the eye an atom broadcasts but a radio tube whose mechanism is on a larger scale requires an oscillating spark.

No two instruments of an orchestra sound alike though they be alike in pitch, each colors the song it sings. The skin and ear and eye are instruments. My warm hand feels cool in water which to my cool hand seems warm. In the silence of a forest one may almost hear the thrust of root and stem! I look from grass to fence and white-washed fence seems tinged with red. But if my eye lingers first on the red barn the fence seems green. The eye fatigued for green or red, as the case may be, sees in white all colors blended except that green or red which with them would yield white. Yesterday when I went from sunshine into a room lighted by a mercury arc my "blue" gown was violet. Which time did my eyes tell more truly! Having received a conditional sense registration it passed along by a mechanism little known to an unreliable, a prejudiced mind. There is a recently published poem by James Stephens[1] which says, speaking of eyes and ears and sense of touch,

> "They give that lazy imbecile
> —The mind—a sight, a sound, a feel:
> And he resolves with wisdom fit,
> That It is That, and That is It:
> Nor wots that It and That and Us
> Are utterly not these, nor thus."

Certainly it is legitimate to conjecture whether we have by touch and ear and eye, whether by radio tube and electroscope, discovered all of the dance. Why should there be fifty-six octaves of radiation, or thereabouts, no more, no less—why not unbounded like the universe!

Professor A. S. Eve, in his presidential address before the Royal Society of Canada in 1930[2] said in part "It is a remarkable fact that, in physics, energy has an intimate relation with time, and also with frequency; so that it is a particular fad of the author to endeavor to ascertain to what extent we can substitute the frequency of waves for the perhaps less tangible, but more familiar, concept of energy. . . . It may be possible to consider energy as an aspect of frequency, possibly arriving at a comprehensive wave theory of the universe."

Many years ago when Duse was in her prime I saw her in

---

[1] *Strict Joy.*
[2] *Science*, May 23, 1930.

Camille. I understood not one word of her language. I still see those marvellous hands and the tones of her voice registered upon my ear for all time.

My sister's dog understands her and me. He goes to her for his dinner; comes to me for his ball. He understands the import of our words as I understand the import of Duse's. My friend cheers me not so much by what she says—it is the significance behind the symbols that is dynamic.

Professor C. G. Darwin of the University of Edinburgh, in a recently published book,[3] says that there are two half worlds —the wave-aspect and the particle-aspect. "There is nothing of the same kind anywhere else in scientific thought," he says, "but the absolute separation, yet interdependence, can perhaps be compared to a similar separation in metaphysics. There is a close interdependence between the objective thing that we see or hear and our subjective sensation of sight or hearing, and yet the two use wholly different languages . . . I think," he continues, "that it is best to regard the wave-aspect (that is, the wave-length and frequency)[4] as analogous to the objective world, and the particle-aspect (momentum and energy corresponding, according to Professor Darwin, to wave-length and frequency, respectively)[4] to the subjective; for example, we have a very direct and intimate perception of what a particle means if we are hit by a bullet, and, on the other hand, we have no intimate knowledge whatever that light and sound have anything to do with waves." The two aspects, wave and particle, are, according to Professor Darwin, whether of electron or proton, atom or molecule, photon or other "body," linked together in some way by that quantum which spans energy levels when radiation escapes from whatever entity. May not thought be a wave! May it join the dance of energy! To one who in a darkened room has observed the rhythmic luminous interplay between two separated electrical charges while occasional flashes leap the gap, there seems small difficulty in the idea of thought transference, with space and time shrunk to insignificance for the leap of a winged thought.

---

[3] *New Conceptions of Matter*, published November, 1931.
[4] The parenthetical explanations are mine.

EASTERN ASSOCIATION OF PHYSICS TEACHERS

One Hundred Twenty-first Meeting

ENGLISH HIGH SCHOOL, LYNN, MASSACHUSETTS

Saturday, May 14, 1932

PROGRAM

9:45 Meeting of the Executive Committee.
10:00 Business Meeting.
10:15 Reports of Committees.
10:30 Address of Welcome: Principal Frederic R. Willard of the Lynn English High School.
10:45 Address: "What to Teach in Radio." Mr. William E. Smith, English High School, Boston.
11:15 Discussion: "To What Extent Shall Secondary School Physics Be Mathematical?"
Mr. Homer W. LeSourd, Milton Academy.
Mr. Ambrose B. Warren, Dorchester High School for Boys.
11:45 Address: "Some Unusual Physical Problems in Electrical Measuring Instruments." Mr. B. W. St.Clair, General Electric Company.
12:45 Luncheon. Price, seventy-five cents.
1:45 Motion Picture with Synchronized Sound. "Oil Films on Water." Dr. Irving Langmuir, Assistant Director, General Electric Research Laboratories.
2:45 Visit to the Standardizing Laboratory of the General Electric Company.

OFFICERS FOR 1932-1933

President, Louis A. Wendelstein, High School, Everett, Mass.
Vice-President, Hollis D. Hatch, English High School, Boston, Mass.
Secretary, William W. Obear, High School, Somerville, Mass.
Treasurer, William F. Rice, Jamaica Plain High School, Boston, Mass.

BUSINESS MEETING

The following amendment to the constitution was proposed, to be acted upon at the next meeting. Sec. V. Article 3, first sentence. To change the word "first" to "last" and the word "calendar" to "school," so that the amended sentence shall read . . . "The officers shall be chosen at the last regular meeting of the school year."

Mr. Francis Dole of the Senior High School, Brewer, Maine, was elected an associate member.

The President appointed Mr. Frederick M. Boyce to serve as a member of the committee on College Entrance Requirements.

It was voted that the thanks of this Association be extended to those connected with the Lynn English High School who helped with the preparation of the program and who received us so hospitably.

REPORT OF COMMITTEE ON MAGAZINE LITERATURE AND NEW BOOKS

By Mr. Carl W. Staples, *Chairman, Chelsea High School*

MAGAZINE ARTICLES

Historical.—*Antiques*, May, 1932. "David Rittenhouse—His Clocks" (Early American clock-maker and astronomer).

Meteorology.—*The American Mercury*, May, 1932, page 69. "Ball Lightning," by Charles Fitzhugh Talman.

Television.—*Bell Telephone Quarterly*, April, 1932. Largely given over to television articles.

Radium.—*Literary Digest*, April 30, 1932, page 30. "Canada's Air Rush for Gold and Radium."

Photoelectric Cells.—*Popular Mechanics*, May, 1932, page 772. "How Safe is Your Home." (Uses of photoelectric cells) by William J. Burns.

New Methods in Drilling Oil Wells.—*Popular Mechanics*, May, 1932, page 804. "Tattle-Tale Steel Brains," by Joseph D. Mountain.

Spectroscopy.—*Popular Mechanics*, May, 1932, page 813. "Science Finds New Spectra."

Astronomy.—*Scientific American*, May, 1932, page 268. "New Light on Pluto" by Henry Norris Russell, Ph.D., *ibid.*, page 272. "Watching the Creation of the Stars," Sir James Jeans.

L'Illustration, April 23, 1932. "Les Conceptions Modernes sur la Disposition de Notre Univers." (A partial translation of the same article with accompanying illustrations appears in the *Illustrated London News* of the same date.)

Hydraulics.—*Mechanical Engineering*, April and May, 1932. "The National Hydraulic Laboratory" (Bureau of Standards), by Herbert N. Eaton.

Engineering Progress, April, 1932, page 94. "Hydraulic Press for Extruding Non-Ferrous Metals," by Dr. E. Pfann, Düsseldorf.

Electric Lighting.—*Power Plant Engineering*, May 1, 1932, page 373. "New Sodium Vapor Lamp Has High Efficiency."

Transportation.—*Railway Age*, April 30, 1932, page 718. "C and O Inaugurates 'George Washington's Train'," *ibid.*, page 727. "Scope and Character of Pennsylvania A.C. Electrification," by I. V. B. Duer.

General.—*Readers' Digest*, May, 1932, page 104. "The Age of Ingenuity."

World's Work, May, 1932, page 20. "The Utility of Power," by Philip Cabot.

X-Ray.—*Scientific American*, May, 1932, page 278. "The New 'X-ray Microscope,'" by Gaylord Johnson.

NEW BOOKS

Textbooks. *Physics for Secondary Schools*, by Stewart Cushing. Towne, Ginn & Co., Publishers, 1932.

A very clear text-up-to-date in its treatment of subject matter, very well illustrated. The division of sound is especially good.

Reference Books. *Science To-day*, edited by Watson Davis. New York: Harcourt Brace & Co., 8 x 5¼; 310 pages. $2.50.

(Prepared as radio talks by leading scientists.)

Gregory, Joshua Craven, "The Scientific Achievements of Sir Humphrey Davy," London, 1930. 144 pages.

Hughes, Arthur Llewelyn and Lee, Alvin Dubridge. "Photoelectric Phenomena," 1932, XII, 531 pages. This book gives a critical survey of the whole field of photoelectric phenomena.

Palmieri, M. "Relativity, and Interpretation of Einstein's Theory."

Bernard, W. N. et al. "Elements of Heat-Power Engineering," third edition. Part 1. New York, 1929.

Grose, Parlee Clyde, "The Problem of Vertical Flight." McComb, Ohio, 1931, 128 pages.

ADDRESS OF WELCOME

By Mr. Frederic R. Willard
Principal of the Lynn English High School

Mr. President and Members of the Eastern Association of Physics Teachers:

You may be sure that I am very glad as Principal of the Lynn English High School to welcome you to our new building. The City of Lynn has been generous in its effort to furnish this school with everything that should help to make administration and instruction effective. My words will be borne out as you inspect the building. We all have a just pride in what has been given us.

But after all has been said in praise and pride for physical layout in plant and equipment, we still find ourselves in the humble, fearful presence of the awful fact that a teacher on one end of a log and a pupil on the other end is all that we actually need to set up a school. No matter what magic is wrought on the log and regardless of how much money and skill are expended to make it palatial in appearance and furnishings, the essential relationship of teacher and pupil must still remain unchanged. There are no modern improvements in the learning process or in the art of thinking. Both are as old-fashioned as human nature. Teaching must still be appropriate, meaningful, and with the pupil in mind. The art of learning is now as always very much dependent upon right attitude, lively interest, and adequate mental capacity. When this teaching and this learning are taking place, neither teacher nor pupil is conscious of architecture or equipment. Neither is especially involved in the real job of the school. I am led to make this trite observation; merely to remind ourselves while in convention that whatever is said or done here must, to be fruitful, contribute to making us ideal teachers of children—not pedants or peddlers of facts. We should come out of all conferences better able to discriminate in our selection of subject matter, with increased power to interest in our presentation of it, and with greater likelihood of success in creating in pupils an intellectual curiosity to know more and more about the scientific world in which we live. Perhaps nothing will ultimately make us tolerant and open-minded so much as the scientific attitude that seeks to subject everything to laboratory method of searching analysis for the sole purpose of getting at the truth which alone makes us free.

The two great phases of life are science and poetry. We need them both.

They are entirely different but never antagonistic. One is intellectual and the other is spiritual. One is reasonable and the other imaginative. The two together make up the whole of life. Neither one alone is adequate in the art of living, which after all is greater than making a living. For no man can possibly appreciate or interpret the world in which we live without calling to his assistance at once and to the end, both fact and fancy, the material content and its spiritual significance.

Very briefly, therefore, it is my belief that hardly any subject in the curriculum lends itself so directly to character building as the teaching of science, but, of course, this profitable result can be won only as the teacher himself believes in the ultimate aim and purpose of scientific study.

What I am trying to say is a thousand times more forcefully said in the words of Huxley:

"Modern civilization rests upon physical science, for it is physical science that makes intelligence and moral energy stronger than brute force. The whole of modern thought is steeped in science. It has made its way into the works of our best poets, and even the mere man of letters, who affects to ignore and despise science, is unconsciously impregnated with her spirit and indebted for his best products to her methods. She is teaching the world that the ultimate court of appeal is observation and experience, not authority. She is creating a firm and living faith in the existence of immutable moral and physical laws, perfect obedience to which is the highest possible aim of an intelligent human being."

This brief statement embodies largely my own personal scientific creed.

WHAT TO TEACH IN RADIO

By Mr. William E. Smith *of the English High School, Boston*

SOME EXPERIMENTS THAT DEMONSTRATE THE UNDERLYING PRINCIPLES OF RADIO COMMUNICATION

The apparatus needed for these experiments is: a milliammeter, a hand magneto, a crystal, a radio tube (201A or a 112), two 45 volt B batteries, a 6 volt storage battery, a 4½ volt C battery, and a 2 mfd. fixed condenser.

1. To demonstrate the use of a detector.—The frequency of sound broadcasting is from 500,000 to 1,500,000. These frequencies are, of course, too great to operate a receiving set for two reasons. First, because of the inertia of the loud speaker diaphragm, and secondly, because the ear cannot detect sounds with a frequency over 20,000. Connect in series a milliammeter, and a hand magneto. Rotate the magneto armature rapidly. The needle stays on the zero reading. Put the crystal in the circuit, and turn the armature as before. Now the needle indicates a direct pulsating current.

2. The Edison effect.—Heat the filament of the tube by the 6 volt battery. Put in series the milliammeter, the plate of the tube and the 45 volt B battery. The milliammeter shows that a current is flowing from filament to plate. By changing the plate voltage, a larger or smaller plate current may be demonstrated.

3. Effect of the grid.—Connect as for the Edison effect. Use the 4½ v. C battery. Connect the C+ to the A— and the C— to the grid. Alternate the battery wires between C+ and C—. The plate current will diminish or

increase as the grid is made negative or positive. If a table of the plate current strength is put upon the black board with and without the grid effect, it is demonstrated that a slight grid voltage has a much greater influence on the plate current strength than a large change in the plate voltage.

4. To demonstrate the action of the radio tube.—Connect as for the Edison effect. Connect the magneto with the grid; one magneto lead on the grid, the other lead on the A—. Rotate the magneto armature. The milliammeter proves that a direct pulsating current is the result. If the milliammeter is replaced by a loudspeaker, clicks may be heard as the plate current varies in strength. This experiment illustrates the operation of a one tube set; the only difference in the hook up being that in a radio set the grid is attached to the tuning device and the antenna.

5. Tuning by capacity.—Two aluminum pie plates are connected to the variable condenser posts with the condenser plate not meshed at all (capacity thus being zero). By moving the aluminum plates back and forth, different stations may be brought in.

6. A condenser stores up electricity.—Connect a 2 mfd. fixed condenser in series with 90 or 110 volt D.C. Disconnect the condenser from the charger and bring the two wires near each other. A spark may be seen and heard.

7. *An A.C. current will pass through a condenser, and a D.C. current will not.*—Connect in series a 10 watt lamp and a 2 mfd. fixed condenser first with a 110 D.C., and then with a 110 A.C. The lamp will light with the 110 volt A.C., but not with the 110 D.C. Interesting results with a radio tube connected as for the Edison effect may be demonstrated by touching the grid with a charged vulcanite rod, and then with a charged glass rod. The effect on the plate current will provoke a discussion which will help fix the function of the grid.

8. If the detector circuit is mounted spread out on one board, and the first audio stage on another with different colored wires for the different circuits, all the circuits are plainly visible. Also by putting the loud speaker in the plate circuit of the detector stage, and then putting it in the first stage of audio, the amplifying effect of that stage is forcibly demonstrated. The boards for the second part of this experiment can be placed side by side and connections between the detector stage and the first audio stage clearly shown.

TO WHAT EXTENT SHALL SECONDARY SCHOOL PHYSICS BE MATHEMATICAL?

By Mr. Homer W. LeSourd, *of Milton Academy*

At the last meeting of the Eastern Association of Physics Teachers, Mr. Howard in his vice-presidential address presented some thought-provoking, heart-searching questions which reflected with almost uncanny insight, the mental attitude of a host of physics teachers who are not altogether satisfied with things as they are. It may be profitable to extend the scope of one of his questions "If we really believe that physics has all the values generally claimed for it should we not feel that it ought to be given to every high school student?"

Of course we may not agree in our answers to this question but if we do believe that physics should have a place in the curriculum of every high school student we will be much disturbed by the fact that its enrollment which was once about 22 per cent has fallen to less than 7 per cent in American high schools. Naturally we are led to inquire "Is it the problem work of elementary physics which is responsible for its apparent unpopularity?" and here we have a question which can be answered and we base our conclusion on definite objective evidence. The study of the science curriculum made by Dr. John L. Tildsley in 1928 contained replies from 3842 physics students in the New York City high schools and 1128 of these stated that they got least benefit from the mathematical parts of the subject. No other feature of the course seemed to be particularly unpopular with these students. Whether or not we wish to accept the students' point of view we probably all deplore the fact that many valuable parts of the physics course receive scant attention because of the time we devote to problem work.

"To what extent shall secondary school physics be mathematical?" is a question of perennial interest to physics teachers. Its answer may be indeterminate but it should be worth while for us to exchange views on the subject. My own duty will be discharged when I have presented a few questions and suggestions for the purpose of opening the discussion.

Professor Black reports that American textbooks of elementary physics have had but a limited sale in England because they are considered to be too easy; at least this is the opinion of English teachers. The opinion that they should be more mathematical is probably shared by some American physics teachers. Teachers with a substantial background of advanced physics or of engineering are usually of the opinion that mathematical problems provide the surest methods of testing the students' grasp on fundamental concepts and principles and that physics at any level is essentially mathematical. These teachers may be counted on to resist any attempt to further dematematize secondary school physics. To this group should be added the teachers of college physics who insist, quite properly that the secondary school physics course should provide adequate foundation for college courses in the subject and this requires that it be largely of a mathematical nature.

Perhaps with some effort, we can for a moment, divorce the question from any consideration of college physics or college entrance and restate it thus "Are the educational interests of the average high school student best served by a physics course which is dominated by mathematics?"

The opinion of Professor Michelson on the place of mathematics in secondary school physics has been frequently quoted. "The fact that most of my own investigations have been in the direction of accurate quantitative work may be taken as an indication of the very high value I place upon this side of scientific education but I would venture to submit the opinion that not only does the subject when treated this way defeat its ends by turning away many students—and not by any means the least promising—by presenting a side which to immature minds is certainly not the most interesting."

Let us consider briefly the relative value of the mathematical and the non-mathematical question as a means of testing the student's mastery of

physics. Some will claim that the former type supplies more definite, objective evidence regarding his effort and achievement while those opposed to the almost exclusive use of numerical problems may, in reply, raise the question "how much of a knowledge of physics is really shown by substituting numerical values for symbols and securing a correct answer by solving a simple equation?"

A recent study of physics texts in common use showed in these books, an almost even balance between the two kinds of question; college entrance examinations of recent years have not departed far from the same ratio and we may reasonably conclude that most teachers of high school physics attempt to give their students some such "balanced diet."

The introduction of much new and valuable material into the physics course with the passing years demands some internal readjustments since there is but a little hope that the time allotted to the subject will be increased. In view of these inexorable conditions it seems wise for teachers to select with much care the particular numerical problems which they assign. Problems which require an excessive amount of arithmetical computation should in general be avoided. The problem whose function seems to be primarily that of preparation for advanced physics may well give place to another which is inherently more interesting to the student because of its more practical aspect. And finally, the teacher should ask himself the question "is there any virtue in solving ten problems all employing the same principle or formula?" After a very few problems we approach a stage of diminishing returns for any further efforts.

The membership of this association includes at least six writers of physics textbooks, a considerable number of past and present readers for the College Entrance Examination Board and many others whose years of experience qualify them to contribute to the discussion of this question and it is sincerely hoped that they will respond. The specific questions which we present are these;

Should we attempt to secure a larger enrollment in our physics classes?

If this is desirable, can it be accomplished by reducing materially the mathematical content of the course?

To what extent should problem work occupy the time allotted to physics?

Is the mathematical question in general, more satisfactory than the non-mathematical one?

About what ratio should be maintained between the two types of question on the examinations of the College Entrance Examination Board?

TO WHAT EXTENT SHALL SECONDARY SCHOOL PHYSICS BE MATHEMATICAL?

By Mr. Ambrose B. Warren *of the Dorchester High School for Boys*

The answer to this question appeals to me as being dependent upon what we have set before us as aims and purposes in the teaching of physics, as well as upon the mathematical preparation and scholastic abilities of our pupils. As regards the aims and purposes in the teaching of our subject, I think physics teachers are to be congratulated that they are dealing with a subject in which the objectives are not static. Because certain eminent

teachers of physics in the vicinity of Boston in the early '90's recognized the teaching of physics as a subject likely to be steadily changing and sure to present many problems worthy of study they formed this association in the days when the great topics of discussion were laboratory work and college entrance requirements.

Those of you who have the files of the early publications of this association will find there several studies made by committees of this association. These were among the earliest contributions to physics teaching, and were made before there were scientific journals devoted to the publication of such material. But among those studies, so far as my knowledge goes, there was none which touched the real cause of the tremendous decline in the popularity of physics—the over emphasis of mathematics, nor have there been many outstanding studies of this phase of our problem through the years. In the early years of this century the teachers in secondary schools were yielding quite complacently to the requirements in laboratory and classroom work as laid down by the colleges, and I think very likely failed to realize the difficulty which was facing the standing of physics in the high school program of studies.

When the Commission on the Reorganization of Secondary Education of the National Education Association made its Report on the Reorganization of Science in Secondary Schools the claim was made that science instruction is especially valuable in the realization of six of the seven main objectives known as the "Cardinal Principles of Secondary Education."[1] And the Commission in its conclusion after setting forth the cardinal principles said: "It is the firm belief of this commission that secondary education in the United States must aim at nothing less than complete and worthy living for all youth, and that therefore the objectives described herein must find place in the education of every boy and girl."[2]

With such recognized importance for the sciences most public secondary schools require at least a year's work in a laboratory science for partial fulfillment of diploma requirements, and yet teachers of physics find themselves faced with the fact that the most fundamental subject of all of the sciences is the least attractive to pupils and has been steadily on the decline for several years. "In 1910 physics was studied by 14.6 per cent of the total enrollment (in public high schools of the country), and in 1928 by 6.9 per cent. As physics is generally a fourth-year subject, and since the proportion of students in the fourth year has been increasing, the drop is even greater than these figures indicate."[3]

If the mathematical phase of high school physics has been the stumbling block and the cause of failures among the pupils studying physics as well as the cause of its unpopularity as an elective, is it not reasonable to hope that some modification of this phase of the work may be brought about that will make such applications of mathematics as are necessary bear a reasonable relation to the mathematical accomplishments of the pupils? In this respect again I feel that the physics teacher is fortunate in that his subject

---

[1] U. S. Bureau of Education, *Bulletin*, 1920, No. 26, p. 12.

[2] U. S. Bureau of Education, *Bulletin*, 1918, No. 35, p. 32.

[3] U. S. Bureau of Education, *Bulletin*, 1929, No. 35, p. 10. Statistics of Public High Schools, 1927-'28.

is of such a nature that it is possible to differentiate the courses and thus to some extent avoid failures and make the courses more attractive to those who are lacking college preparatory mathematics.

Physics is a study of relationships, and as such we cannot expect to demathematize it completely. To do so would destroy the very frame work of the subject matter structure, but to vitalize it by giving the pupil some chance to see its tremendous contributing value not only as the basic science, but as one whose applications are modifying and influencing our entire social structure and civilization is more in keeping with what must be done, if physics is to hold the place it deserves in meeting the modern aims of education. These aims look to a more comprehensive development of the pupil to acquaint him with his environment and prepare him for reasonable reactions in the world in which he is to live, rather than to narrow his education by emphasis on knowledge of facts and subject matter of his various studies.

As has been said physics is a subject which cannot be entirely stripped of its mathematical character, but the extent to which mathematics shall be used can be varied within certain limits. The teacher of physics has a right to plan his work on the assumption that pupils are fitted to apply the mathematics in which they have earned passing grades. So in answer to the question: To what extent shall secondary school physics be mathematical? I believe that the teacher of physics should plan his course with due consideration of the extent to which his pupils are prepared, and since the laws and principles of physics can best be visualized and understood when real quantitative values of not too complex nature are introduced, I thoroughly believe in using mathematics as a tool for the purpose of greater clearness, and I do not find boys who know how to apply their algebra and geometry offering any objections. On the contrary I think they take pride in being able to "figure out" an exact answer to a problem.

That some classes in high school physics should have a mathematical requirement is perfectly reasonable, because investigations have shown that the mathematics required for problems in high school physics is not difficult and does not involve information beyond the usual arithmetic, algebra, and plane geometry. The difficulty comes from selecting numerical values that immediately distract the mind from its attention to the scientific principle involved and divert the attention to the solution of a complex mathematical equation. The pupil is unable to see the forest because of the trees. Carried to the extreme one finds his pupil losing sight of the principle involved and its relation to the whole scientific knowledge because of some trifling detail in mathematics.

In a large comprehensive high school one finds such a variety of programs that he may face the situation of presenting lessons in physics to pupils who have had no algebra or geometry, whose mathematical training does not go beyond arithmetic. Should they be permitted to study physics and if so to what extent should the course be mathematical?

To the first question my answer is emphatically "Yes." Because I believe in the fundamental values of physics, and I know that the subject is so extensive that a year's work of a qualitative nature involving real thinking is possible. And in suggesting a qualitative course I do not mean free entertainment at descriptive lectures and informational movies, but I mean a

progressive course in the study of phenomena that will require application of thinking processes, if one is to arrive at their explanations. I believe that is what our former fellow-member Professor Franklin of Massachusetts Institute of Technology meant when he said: "It is not important that high school physics should be quantitative or mathematical, it should be phenomenology."[4]

Professor H. E. Clifford, also of the Institute, speaking before this association once said: "In any course of physics the fundamental instruction should be by classroom work which should be made more vital by the laboratory. The classroom comes first in usefulness and efficiency in instilling the fundamental ideas, and the laboratory second. . . . The laboratory work should be qualitative, not quantitative. It should aim at accuracy in observation, not accuracy in measurement. The explanation of everyday phenomena is the true function of high school physics."[5]

In contrast to this is the attitude of those who take a decidedly classical view of the situation. Rusk in his "How to Teach Physics" quotes Professor Pierce of Harvard as follows: "Mathematics is not the discoverer of laws, for it is not induction; neither is it the framer of theories, for it is not hypothesis; but it is the judge of both, and it is the arbiter to which each must refer its claims; and neither law can rule nor theory explain without the sanction of Mathematics."[6]

And the following from Professors Randall, Chapman, and Sutton of Western Reserve University in 1918: "In the opinion of the authors if anything worthy of the name of physics is to be taught, this process of making the subject attractive and easy by dematematizing it must cease; for in attempting to eliminate the excessive growth of algebraic formulae, we have already dangerously weakened the sustaining framework of fundamentals. . . . And finally, for the inculcation of exact thinking, it is not sufficient to learn the why and how of a given phenomenon, but also the how much to be able to judge the relative effects of interacting causes, to separate the more important facts from the less, and to estimate the result with some degree of precision."[7]

Nevertheless I wish to advocate courses in physics so inconspicuously mathematical that the valuable lessons to be learned from a study of the principles, their numerous applications, and far reaching influence may be the privilege and enjoyment of every high school pupil. It seems to me that a pupil in a general course who successfully overcomes the obstacles that he meets in assembling the parts of an electric motor, such as the position of the brushes, proper winding of the field coils, etc., and finally presents before the class a properly working product upon which he has written a report, has had his education advanced fully as much as the pupil in the college preparatory course who laboriously tries to calculate by the use of inaccurate apparatus, subject to every possible source of error, and a somewhat complicated formula the number of intangible, invisible, and elusive calories which came in through the gas pipe and somehow got mixed in with some copper shot in the inner container of a double boiler.

---

[4] John F. Woodhull, *The Teaching of Science*, p. 33.
[5] *Ibid.*, p. 32.
[6] Rogers D. Rusk, *How to Teach Physics*, p. 56.
[7] *School Review*, 26:39-43, 1918.

One may get vast enjoyment, inspiration, and breadth of knowledge by a study of astronomy without the application of any mathematics beyond the most elementary, and to me the subject of physics appeals in much the same way.

I think Rusk voices my feelings in this matter when he says: "Those who are crying for secondary school physics to throw off the burden of mathematics and become descriptive, should carefully consider their position and what they mean by descriptive. Mathematics should certainly not be loaded on the high school physics pupils in the form of a burden, but without the adequate use of mathematical forms neither methods of, nor appreciation of, precise thinking about physical phenomena can be developed. What is needed today is not an attempt to develop embryo mathematical physicists, but a more frequent use of simple mathematical forms by all. Even in elementary physics the pupil should be led to look upon the mathematics he uses, either as simplifying the subject and making it more intelligible, or as making it directly applicable and useful. More mathematics than the pupil can thus use is useless and confusing."[8]

SOME UNUSUAL PHYSICAL PROBLEMS IN ELECTRICAL MEASURING INSTRUMENTS

By Mr. B. W. St.Clair *of the General Electric Company*

SUMMARY

In this problem are involved principles from Physics but also from other sciences such as Chemistry, Bacteriology, Mineralogy, Geology, and Biology.

The d-c. instrument presents many problems. Consider the armature, for instance, which weighs about half a gram. It has very high torque which must be known accurately. The bearings, too, must be practically frictionless. This means that the area should approach very nearly a point. But that would make the pressure near to infinity so practically the point is rounded a bit but still the bearing pressure is often as great as six tons per square inch.

Unusual materials are needed for these bearings. They must be capable of taking high polish. Very hard steels working with some form of Al_2O_3 such as sapphire or agate are suitable. The quality of these bearings varies with the country from which the sapphire comes, how they are cut, how much work is done in polishing them and the people from whom they are bought. They are polished with diamond dust, one gram of which will be sufficient to polish 15,000 surfaces.

Lantern slides were shown comparing the points of a pin and a needle with a sapphire pivot. Also a set of naturally occurring sapphire crystals showing various shapes, weathering, twins, and rare occurrences. Another set of slides showed the micro-structure, giving evidence of bubbles, intrusions of rutile, and color bandings. Under increasing magnification these may be profitably studied. The originals of these stones and others spoken of were on exhibition.

---

[8] Rogers D. Rusk, *How to Teach Physics*, p. 56.

Wholesale dealers in precious stones proceed on the well-known principle of "caveat emptor" and since synthetic stones are not as suitable for bearings as the natural sapphire it is necessary to be able to distinguish the natural from the synthetic. Manufactured sapphires and rubies make excellent appearing gem stones but since they may be produced for about 45 cents an ounce they are not in the same class with real rubies which may be worth $10,000 a carat ($1,500,000 an ounce).

The apparatus for detecting natural stones was explained and shown on the screen. In the afternoon we had the rare privilege of seeing it in operation. A discharge in a Coolidge tube produces electrons which are shot through a very thin steel plate out into the open air at a very high velocity. When they strike various minerals such as calcite, Willemite, etc., they cause some to fluoresce and others to phosphoresce. Even the amateurs can distinguish the synthetic stones from the natural by their appearance in this stream of electrons.

Mr. St. Clair also discussed briefly the problems involved in producing springs for the meters which must keep the pointer at rest on zero under trying conditions and must also make it register exactly under different loads.

The afternoon program offered two features neither of which lends itself to a printed report. The large number of members who stayed, however, were enthusiastic over the film and the visit to the General Electric Standardizing Laboratory. Members who seldom attend the meetings should realize that they are not receiving full value from their Association. The personal contact with other members, the opportunity of seeing experiments and teaching devices actually presented by those who are using them successfully, and the possibility of visiting plants and laboratories not open to the general public and of having one's questions answered by eminent experts are phases of the work of this Association which members cannot afford to miss. WILLIAM W. OBEAR, Secretary

---

PROBLEM DEPARTMENT

CONDUCTED BY G. H. JAMISON
State Teachers College, Kirksville, Mo.

This department aims to provide problems of varying degrees of difficulty which will interest anyone engaged in the study of mathematics.

All readers are invited to propose problems and to solve problems here proposed. Drawings to illustrate the problems should be well done in India ink. Problems and solutions will be credited to their authors. Each solution, or proposed problem, sent to the Editor, should have the author's name introducing the problem or solution *as on the following pages.*

The Editor of the department desires to serve its readers by making it interesting and helpful to them. Address suggestions and problems to G. H. Jamison, State Teachers College, Kirksville, Missouri.

SOLUTIONS OF PROBLEMS

Editor.—Persons sending in solutions should read carefully the instructions about the form of the solutions and the ink-drawn figures. Many

times, a good solution is received, but poorly arranged and no India-ink figure given.

1223. *Proposed by Gunther Wunsche, Dresden, Germany.*

For any triangle prove that four times the sum of the squares of the medians equals three times the sum of the squares of the sides.

Solution by Edwin Beggs, Spokane, Wash., The Lewis and Clark High School, Spokane.

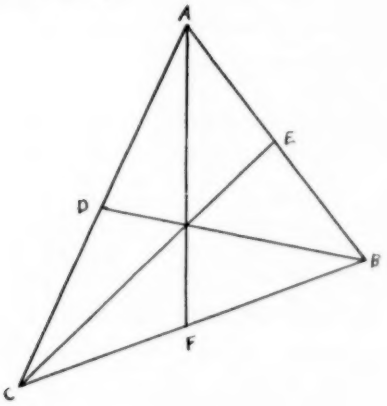
HYPOTHESIS: ΔABC with its medians.

CONCLUSION: $4(\overline{CE}^2 + \overline{AF}^2 + \overline{BD}^2) = 3(\overline{AB}^2 + \overline{BC}^2 + \overline{AC}^2)$

Statements:

1. $\overline{AB}^2 + \overline{BC}^2 = \frac{1}{2}\overline{AC}^2 + 2\overline{BD}^2$

(In any triangle the sum of the squares of two sides is equal to twice the square of one-half the third side increased by twice the square of the median to the third side.)



2. $\overline{AB}^2 + \overline{AC}^2 = \frac{1}{2}\overline{BC}^2 + 2\overline{AF}^2$ (Same as step one.)

3. $\overline{BC}^2 + \overline{AC}^2 = \frac{1}{2}\overline{AB}^2 + 2\overline{CE}^2$ (Same as step one.)

4. $2\overline{AB}^2 + 2\overline{BC}^2 + 2\overline{AC}^2 = \frac{1}{2}\overline{AC}^2$ (Add steps 1, 2, and 3.)
$+ \frac{1}{2}\overline{BC}^2 + \frac{1}{2}\overline{AB}^2 + 2\overline{BD}^2 + 2\overline{AF}^2$
$+ 2\overline{CE}^2$

5. $4(\overline{AB}^2 + \overline{BC}^2 + \overline{AC}^2) = \overline{AC}^2$ (Multiply (4) by 2.)
$+ \overline{AB}^2 + \overline{BC}^2 + 4(\overline{BD}^2 + \overline{AF}^2$
$+ (\overline{CE}^2$

6. $4(\overline{CE}^2 + \overline{AF}^2 + \overline{BD}^2) = 3(\overline{AB}^2 + \overline{BC}^2 + \overline{AC}^2)$. Subtract $(\overline{AC}^2$
$+ \overline{AB}^2 + \overline{BC}^2)$.

Also solved by D. Moody Bailey, Rock, W.Va.; R. T. McGregor, Elk Grove, Calif.; Andrew Sobezyk, Duluth, Minn.; Samuel M. Cohn, Philadelphia, Pa.; Mack Tacker, Bremen, Ind.; A. MacNeish, Chicago, Ill.; H. R. Harold, Tonkawa, Okla.; Adrian Struyk, Paterson, N.J.; W. E. Buker, Leetsdale, Pa.; Martin Bowman, Philadelphia, Pa.; Charles W. Trigg, Los Angeles, Calif.; Paula Schroeders, San Antonio, Texas; M. R. Dickter, Philadelphia, Pa.; and the Proposer.

1224. *Proposed by P. H. Nygaard, North Central High School, Spokane, Wash.*

The aproximate location of Rome is long. 12° 30′ east, lat. 42° north and of Chicago is long. 88° west, lat. 42° north. (a) What is the distance in statute miles from Chicago to Rome if a due east course is followed? (b) What is the distance in statute miles along the great circle course? (c) What is the latitude of the point farthest north along the great circle course? (Assume that the earth is a sphere with a radius of 3956 miles.)

A. *Solution by proposer*

The distance around the earth along the 42° parallel is 3956 x sin 48° $\times$ 2π = 18470 miles. The distance along this path from Chicago to Rome is $\frac{100.5}{360} \times 18470 = 5156$ miles.

B. *Solution by Vernon Godsey, Spokane, Washington.*

To find the great circle distance solve by using the formula from spherical trigonometry, cos x = cos A cos B cos D + sin A sin B, where A equals the latitude of one point, B equals the latitude of the other, D equals the difference in longitude of the two points, and x the number of degrees in the great circle distance. Substituting these values and solving, x = 69° 41.5′. Substituting the known values in the formula; length of arc = angle $\times$ radius, the distance is found to be $\frac{69° \ 41.5'}{180°}$ $\times$ 3956 mi. = 4811.8 miles.

C. *Solution by the proposer*

By solving the spherical right triangle whose vertices are Chicago, the north pole, and the place farthest north on the great circle through Chicago and Rome, it is found that the farthest north point is 35° 23′ from the pole or at a latitude of 54° 37′.

Also solved by D. Moody Bailey, Rock, W.Va.; and Mack Tucker, Bremen, Indiana.

1225. *Proposed by Henry Schroeder, Ruston, La.*

A circle of radius *a* moves with its center on the circumference of an equal circle, and keeps parallel to a given plane which is perpendicular to the plane of the given circle. Find the volume of the solid it will generate. Use rectangular co-ordinates and single integration.

Solved by Charles W. Trigg, Los Angeles, Calif.

The fixed circle was taken with its center at the origin and resting in the *XZ*-plane. The moving circle therefore remains parallel to the *XY*-plane. Figure 1 shows a front view of the solid generated, and Figures 2, 3, and 4 show sections through the solid by planes parallel to the *XY*-plane at AB, MN, and *X′X*, respectively.

$$DO = DE = DF = a$$

$$DC = \sqrt{\overline{DO}^2 - \overline{CO}^2} = \sqrt{a^2 - z^2}$$

$$\angle EDC = \arccos \frac{\sqrt{a^2 - z^2}}{a}$$

$$\angle EDF = 2 \arccos \frac{\sqrt{a^2 - z^2}}{a}$$

$$EF = 2EC = 2z$$

$$\text{Area of sector } EFDE = \frac{\pi a^2}{2} \times 2 \arccos \frac{\sqrt{a^2 - z^2}}{a} = a^2 \arccos \frac{\sqrt{a^2 - z^2}}{a}$$

$$\text{Area of } \triangle EDF = \frac{2Z}{2}\sqrt{a^2 - z^2} = z\sqrt{a^2 - z^2}$$

$$\text{Area of } EKNLFCE = \text{area of circle} - \text{area of sector} + \text{area of } \Delta$$

$$= \pi a^2 - a^2 \arccos \frac{\sqrt{a^2 - z^2}}{a} + z\sqrt{a^2 - z^2}$$

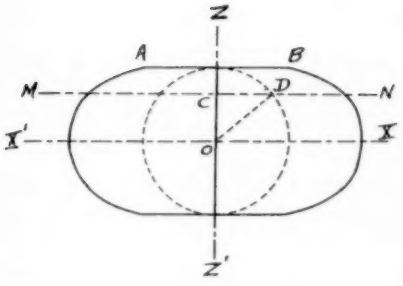


Fig. 1

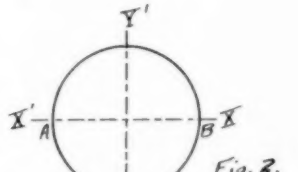


Fig. 2.

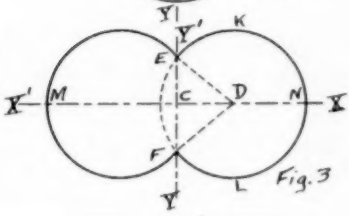


Fig. 3

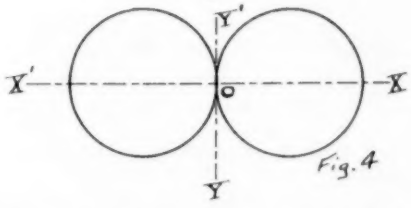


Fig. 4

Consider the volume generated above the XY-plane on the right of the YZ-plane, which will be ¼ the total volume.

$$\frac{V}{4} = \int_0^a (\text{Area of section})dz$$

$$\frac{V}{4} = \left[\pi a^2 z - a^2 z \arcsin \frac{z}{a} - a^2\sqrt{a^2 - z^2} - \frac{(a^2 - z^2)^{3/2}}{3}\right]_0^a$$

$$\frac{V}{4} = a^3\left(\frac{\pi}{2} + \frac{4}{3}\right)$$

$$V = 4a^3\left(\frac{\pi}{2} + \frac{4}{3}\right)$$

Also solved by D. Moody Bailey, Rock, W.Va.; Howard R. Harold, Tonkawa, Okla.; and Paula Schroeders, San Antonio, Texas.

1226. The distances from a point to the three nearest corners of a square are 1 inch, 2 inches, and 2½ inches respectively. Construct the square. (Two solutions)

Solutions by F. A. Cadwell, 611 Central Park Place, St. Paul, Minn.

(The figure is drawn to the scale ⅝ inch equals 1 inch)

SOLUTION 1 (wherein the point is inside the square):

Let O be the point.

1. Draw a right angle OAE, making OA and AE each one inch long.
2. With O as center draw circles having radii of 2 inches and 2½ inches respectively.
3. With E as center and radius of 2½ inches draw an arc intersecting the inner circle at B.
4. Draw BE and BA.
5. Draw a radius, OD, of the outer circle, making the angle AOD equal to the angle AEB.
6. Draw AD.
7. With B and D as centers and radii equal to AB draw arcs intersecting at C, and draw BC and DC.

Then $ABCD$ is the square required.

PROOF. In the triangles AEB and AOD we have: $AE = AO$, $EB = OD$, and $\angle AEB = \angle AOD$. Therefore triangles AOD and AEB are congruent. Therefore $AD = AB$ and $\angle EAB = \angle OAD$.

Therefore $\angle EAB + \angle BAO = \angle BAO + \angle OAD =$ a right angle. That is $\angle BAD$ is a right angle.

Then in the Quadrilateral $ABCD$ we have $AD = AB = DC = BC$ and $\angle BAD$ is right. Therefore $ABCD$ is a square. Also O is inside the square at the given distances from the nearest vertices. Therefore $ABCD$ is the square required.

SOLUTION 2 (wherein the point is outside the square):

1. Same as in solution 1.
2.
3. With E as center and radius equal to 2½ inches draw an arc intersecting the inner circle at B'.
4. Draw $B'A$ and $B'E$.
5. Draw a radius OD' of the outer circle, making $\angle AOD' = \angle AEB'$.
6. Draw AD'.
7. With B' and D' as the centers and radii equal to AB' draw arcs intersecting at C' and draw $B'C'$ and $D'C'$.

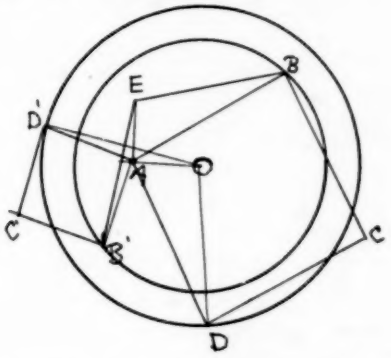
Then $AB'C'D'$ is the required square. The proof is similar to that given for case I.

Now, O is outside the square at the given distances from the nearest vertices.

Also solved by W. E. Buker, Leetsdale, Pa.; Martin Bowman, Philadelphia; Daniel Kreth, Wellman, Iowa; Paula Schroeders, San Antonio,

Texas; D. Moody Bailey, Rock, W.Va.; Charles W. Trigg, Los Angeles, California.

One incorrect solution was submitted.



1227. *Proposed by Samuel M. Cohn, Philadelphia, Pa.*

Given the trapezoid $ABCD$, in which the top base $CD = \frac{1}{2}$ the bottom base AB, and the sum of $\angle BAD$ and $\angle ABC = 90°$. Prove that the square of the bottom base ($\overline{AB}^2$) is equal to four times the sum of the squares of the two sides. [$4(\overline{AD}^2 + \overline{BC}^2$]

Solved by Günther Wünsche, Dresden, Germany.

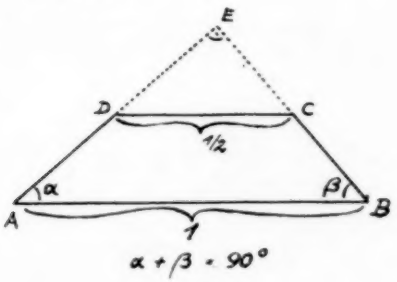
If we lengthen AD and BC we obtain the point E, where $\sphericalangle E = 90°$.

Then we have $\overline{DE}^2 + \overline{CE}^2 = \overline{DC}^2 = \frac{1}{4}$(Let $AB = 1$)

Because $\overline{AD} = \overline{CE}$, $\overline{BC} = \overline{CE}$, we have:

$$\overline{AD}^2 + \overline{BC}^2 = \tfrac{1}{4} = \tfrac{1}{4}\overline{AB}^2$$

or $\overline{AB}^2 = 4(\overline{AD}^2 + \overline{BC}^2)$



Also solved by W. E. Batzer, Battle Creek, Mich.; W. E. Buker, Leetsdale, Pa.; R. T. McGregor, Elk Grove, Calif.; Henry A. Cooper, Woodston, Kan.; Paula Schroeders, San Antonio, Texas; D. Moody Bailey, Rock, W.Va.; Andrew Sobezyk, Duluth, Minn.; A. J. Patterson, Wheeling, W.Va.; Martin Bowman, Philadelphia, Pa.; A. MacNeish, Chicago, Ill.; Charles W. Trigg, Los Angeles, Calif.; and the Proposer.

1228. *Proposed by Arthur J. Kavanagh, Washington, Conn.*

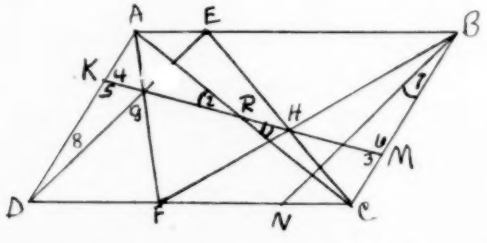
ABCD is a parallelogram, *E* is any point on *AB*, *F* is any point on *CD*, *AF* intersects *DE* at *G*, *BF* intersects *CE* at *H*, *GH* cuts *AD* at *K* and *BC* at *M*. Prove $AK = MC$. Prove by methods of ordinary Plane Geometry.

Solved by N. Nicholson, Mathematics Club of South Philadelphia High School for Boys.

SOLUTION:

1. Draw *AC* intersecting *KM* at *R*
2. $\angle 1 = \angle 2$
3. $\angle 3 = \angle 4$
4. $\therefore \triangle RMC$ and $\triangle AKR$ are similar
5. $\therefore \dfrac{MC}{AK} = \dfrac{RC}{AR}$
6. Draw $BN \| DE$, intersecting *KM* at *P*
7. $\angle 7 = \angle 8$
8. $\angle 5 = \angle 6$
9. $\therefore \triangle PMB$ and $\triangle KGD$ are similar
10. $\therefore$ Quad. *BCPR* $\sim$ Quad. *RGDA*—If 2 polygons are composed of the same number of Δ's similar to each other and similarly placed, the polygons are similar.
11. $\therefore \dfrac{BC}{AD} = \dfrac{RC}{AR}$ — Corresponding sides of similar polygons are similar
12. But $\dfrac{MC}{AK} = \dfrac{RC}{AR}$ — Proven in step number 5.
13. $\therefore \dfrac{BC}{AD} = \dfrac{MC}{AK}$ — things = to the same thing are = to each other.
14. $\overline{BC} \cdot \overline{AK} = \overline{AD} \cdot \overline{MC}$
15. But $AD = BC$—opposite sides of $\square$ are =.
16. $\therefore AK = MC$

NOTE.—This problem appeared in the November issue, 1931, with two solutions. This solution resulting from very elementary considerations is offered.—Editor.



Also solved by Paula Schroeders, San Antonio, Texas; H. Grossman, New York; Adrian Struyk, Paterson, N.J.; W. E. Baltzler, Battle Creek, Mich. (Mr. Batzler's solution makes use of the Theorem of Menalus); A. J. Patterson, Wheeling, W.Va.; D. Moody Bailey, Rock, W.Va.

HIGH SCHOOL HONOR ROLL

The Editor will be very happy to make special mention of high school classes, clubs, or individual students who offer solutions to problems submitted in this department. Teachers are urged to report to the Editor such solutions.

For this issue the Honor Roll appears below.

1223. Arnold Cowan, S. Philadelphia High School; Ned King, Leetsdale (Pa.) High School; Edwin Beggs, Lewis and Clark High School, Spokane, Washington; Carl McNutt, Woodston (Kansas) Rural High School.

1227. M. H. Cohn, New Bedford (Massachusetts) High School; Mike Kuzma, Leetsdale (Pa.) High School; William Wegner and Edwin Beggs, Lewis and Clark High School, Spokane, Washington.

1228. Richard Greenburg, Shortridge High School, Indianapolis, Indiana.

PROBLEMS FOR SOLUTION

1240. *Proposed by Ralph Newman, Clarksville, Arkansas.*

A cube whose diagonal is $2a$ is placed in a sphere whose radius is a. What is the length of an edge of the largest cube which can be placed in one of six equal spaces between the cube and sphere?

1241. *Proposed by H. D. Grossman, New York City.*

Given a circle with chord AB, tangents AP and BP, and chord CD cutting AB in E, AP in F, BP in G. Prove that $CE = DE$ if $CF = DG$.

1242. *Proposed by P. H. Nygaard, Spokane, Washington.*

A cylindrical tank is 12′ long and 5′ in diameter. It is placed with its axis horizontal. If a measuring stick shows it to be filled to a depth of $22\frac{3}{4}''$, how many gallons does it contain?

1243. *Proposed by W. E. Buker, Leetsdale, Pennsylvania.*

Find consecutive integers whose squares have the same digits. State a general method of finding such pairs if possible.

1244. *Proposed by Raymond Freedman, Philadelphia, Pennsylvania.*

Show that X^n is equal to the sum of the consecutive odd integers (starting with one) multiplied by X^{n-2}.

1245. *Proposed by Frank B. Allen, Sparta, Illinois.*

If $C_0, C_1, C_2, \cdots, C_n$ are the coefficients in the expansion of $(1+X)^n$, n a positive integer, show that

$$C_1 - \frac{C_2}{2} + \frac{C_3}{3} - \frac{C_4}{4} + \cdots + (-1)^{n-1}\frac{C_n}{n} = 1 + \frac{1}{2} + \frac{1}{3} + \cdots + \frac{1}{n}.$$

MEN TRAINED TO BE HUMAN CLOCKS

Men can be trained to judge time so that as "human clocks" they run slow by only two-tenths of one per cent, Dr. Samuel Renshaw, of Ohio State University, has reported to the American Psychological Association. Contrary to popular belief, however, tapping with hands or feet or counting increases the error, he said.

SCIENCE QUESTIONS

October, 1932

Conducted by Franklin T. Jones

To Readers of SCHOOL SCIENCE AND MATHEMATICS:

You are invited to propose questions for solution or discussion.

Send in answers to questions.

Examination papers are always desired, send in your own papers or any others. Tests and new things are wanted.

Please address all communications to Franklin T. Jones, 10109 Wilbur Avenue, S.E., Cleveland, Ohio.

Contest at Rochester—Safrin Champion—Test Yourself

WHO IS THE ENGINEER?

595. A train is operated by three men, Smith, Robinson, and Jones. They are fireman, engineer, and brakeman, but not respectively. On the train are three business men of the same names. A Mr. Smith, a Mr. Robinson, and a Mr. Jones. Consider all the data about all concerned.

1. Mr. Robinson lives in Detroit.
2. The brakeman lives half way between Chicago and Detroit.
3. Mr. Jones earns exactly $2000 a year.
4. Smith beat the fireman at billiards.
5. The brakeman's nearest neighbor is one of the passengers and earns exactly three times as much as the brakeman.
6. The passenger whose name is the same as the brakeman's lives in Chicago.

The Question Is— *Who is the Engineer?*

(The above question is reported to be used as a test in selecting employees. Come on, psychologists! Tell us just what it will tell about a candidate's qualifications.)

Answer by Rose F. Safrin, Department Secretary, West High School, Rochester, New York.

This is in answer to the Science Question "Who is the Engineer?" which appeared in the February issue of SCHOOL SCIENCE AND MATHEMATICS. Three people in this department worked the problem and all three decided that Smith is the engineer. Here is the time it took to work the problem.

A Teacher	30 minutes
Lab. Assistant	15 minutes
Dept. Secretary	5 minutes

Will you please let me know if this is the correct answer?

Answer—Smith is the Engineer.

(PS.—Next month we will prove that Jones is the engineer.)

Other solutions from J. S. Georges, Chicago; A. P. Kenyon, Chadwich, Ill.; Herbert S. Lein, N. Tonawanda, N.Y.; Roscoe Powers, Indianapolis; who else?

BRYAN'S BIOLOGY TEST

Request by M. Barbara See, Jamaica Plain High School, Boston, Mass.

"Please print more of those very good biology test questions."

TESTS IN BIOLOGY

598. *Submitted by A. H. Bryan, Baltimore City College, Baltimore, Maryland.*

I am enclosing the complete set of achievement tests, true and false tests, and general review examinations used in my biology classes in the above high school throughout the year. These tests have been used with some moderate changes within the last few years, because they cover all topics in biology, systematically both in theory and laboratory work, you might be interested in publishing some of them. There are so many, of course, that I would suggest you just print one at a time when you have available space for examination questions.

Set No. 1 are not original but designed as a general review set of questions covering every topic in biology. They were culled from several well known text books and quiz compends. The students were given one set of these question papers just before the end of the term. They were required to write out and study the answers to all of the hundred questions. For the actual examination ten questions were picked out of the hundred by the biology teachers here and then given as the final examination for all classes. This complete review proved particularly valuable to students who had to take college entrance examinations.

Set No. 1—Review Examination in Biology

1. (a) What is Biology. (b) Name some divisions of the subject.
2. (a) What is Protoplasm? (b) What are its properties? (c) What is its chemical composition?
3. (a) State why oxidation is essential to the life of animals and of plants? (b) What elements are oxidized in the bodies of animals and of plants? (c) Name the products formed by their oxidation.
4. (a) What does each of the following consist of: water, carbon dioxide, air, soil? (b) What is the importance to plants or animals of each of the above?
5. (a) What is a cell? (b) What are the parts common to all plant and animal cells? (c) State the function of each of these parts. (d) Name two other parts usually present in cells. (e) Make a labeled diagram showing the structure of a typical cell.
6. Define (a) Tissue, (b) Organ, (c) Organism.
7. Explain the following: "The cell is the unit of structure and function."
8. (a) What is meant by the environment of a plant or an animal? (b) What conditions (environment) are necessary for every living plant or animal?
9. (a) What is meant food? (b) Name the principal classes of food substances required by plants and animals.
10. (a) What elements are present in starch? (b) What compounds are formed when starch is burned? (c) What elements are present in protein? (d) What use is made of protein by plants and animals?
11. (a) What is the function of the flower? (b) Make a labeled diagram to show the structure of a typical. (c) Name the parts of such a flower.
12. Describe the essential organs of the flower.
13. Name and define the three steps in the reproductive process of the flower.
14. (a) What is self-pollination? (b) What is cross-pollination? (c) What are the principal agents of cross-pollination?

15. (a) Mention two adaptations by which flowers attract insect visitors? (b) How do these visits benefit both plant and insect? (c) What are the structural adaptations for insect pollination in both flower and insect?

16. (a) What is a fruit? (b) What is its function? (c) State the principal changes that occur after fertilization as the flower develops into the fruit.

17. (a) Why is seed dispersal necessary? (b) What are the principal agencies by which it is brought about? (c) In what three general ways may fruits aid in the dispersal of seeds? (d) Of what advantage to the plant is the unpleasant taste of many unripe fruits?

18. By the aid of several examples show how fruits are adapted by structure for their function (seed dispersal).

19. Make a labeled diagram to show (a) the external and internal structure of a bean pod. (b) the vertical and cross section of an apple. (c) The cross section of an orange. (d) State the use of each of the essential parts.

20. (a) State three differences between the bean seed and the corn grain. (b) What parts of the seed constitute the embryo?

21. (a) Make a series of labeled drawings to show several stages in the germination of the bean seed. (b) State in the order of occurence the the most important developments that take place during germination?

22. What is meant by each of the following: primary, secondary root, tertiary root, adventitious root, tap root, fleshy root, air root, water root?

23. Make labeled drawings to show: (a) the cross-section of a root, (b) a lengthwise section of a root tip. (c) State the function of each part shown.

24. (a) What are root hairs? (b) What is their function? (c) Make a diagram to show the structure of a root hair.

25. (a) What are the functions of the root of a plant? (b) Show how the root is adapted for its function.

26. (a) Name and (b) describe the process by which mineral solutions are taken into a root. (c) By the aid of a labeled diagram describe an experiment to demonstrate the process.

27. (a) Show that the conditions for osmosis are present in root hairs. (b) What processes in plants are based on osmosis?

28. (a) How does the soil water absorbed by the roots differ from ordinary water? (b) Why is soil water necessary for a growing plant?

29. (a) What is meant by a fertile soil? (b) When the soil has lost its fertility what three elements are usually lacking? (c) How may these elements be replaced and the soil's fertility restored?

(*Questions 30 to 100 will be printed in later numbers of* SCHOOL SCIENCE AND MATHEMATICS.)

FOR EARLY PUBLICATION

Physics Achievement Test—Walter E. Hauswald, Beardstown High School, Beardstown, Ill. (Part one is printed below.)

General Science Test—Thomas Edison School, Cleveland. Constructed by H. C. McGuffin, L. D. Mennell, and H. K. Moore.

Follow-up Test—E. L. Huber, Central High School, Lima, Ohio.

PHYSICS ACHIEVEMENT TEST

609. *Prepared by Walter E. Hauswald, Beardstown High School, Beardstown, Illinois.*

Name .....Age——Years——Mos.——

Date of test.....

Directions.—You will be given forty minutes in which to complete this examination, so you must work rapidly. The examination consists of four parts to be completed in the order given. If you find one item particularly difficult proceed to the next item and return to the difficult one if time permits.

The directions for each portion of the test appear at the beginning of that section. Your ability to follow these directions will influence your success with the test, so do as directed.

Ask any questions now! Have two pencils ready!

When your instructor gives the signal you may turn this sheet and begin the test.

Part One

Directions.—Complete the following sentences, writing the proper *word* or *number* in the corresponding space at the right of the page.

1. The name of the metric unit that most nearly corresponds to the yeard is the —*1*—. 1. .....

2. The resultant of two forces is directed toward the east. The equavalent of these forces is directed toward the —*2*—. 2. .....

3. The unit of electrical current is the —*3*—. 3. .....

4. Energy in motion is called —*4*— energy. 4. .....

5. Approximately —*5*— calories of heat are required to change one gram of ice to water at zero degrees centigrade. 5. .....

6. The —*6*— is used to measure air pressure. 6. .....

7. The volume of an object divided by its weight is called the —*7*— of the object. 7. .....

8. Sound travels approximately —*8*— feet per second in air at zero degrees centigrade. 8. .....

9. The —*9*— of a sound is controlled by the number of vibrations per second. 9. .....

10. The —*10*— of the air depends upon the quantity of water vapor contained. 10. .....

11. In the charging of a storage battery electrical energy is changed into —*11*— energy. 11. .....

12. The strain produced in an elastic body is proportional to the —*12*—. 12. .....

13. Heat is transferred through metals by —*13*—. 13. .....

14. The decomposition of a compound by an electric current is called —*14*—. 14. .....

15. —*15*— force causes water to be thrown from a sprinkled grinding wheel revolving at high speed. 15. .....

16. The —*16*— of two forces is one force that will exactly counterbalance the two forces. 16. .....

17. The unit of heat measurement is the —*17*—. 17. .....

18. Dry cells whose positive terminals are all connected together, and whose negative terminals are all connected together are said to be wired in —*18*—. 18. .....

19. The resistance of an electrical conductor is directly proportional to its —*19*—. 19. .....

20. The smallest particle into which matter may be subdivided without destroying its characteristic properties is called the —*20*—. 20. .....

PLEASE RE-READ JUNE

SCHOOL SCIENCE AND MATHEMATICS, pages 664-667, and send to the Editor answers to **606, 608.**

WANTED

Examination Papers—Tests—Trick Questions.

BOOK REVIEWS

Philosophy and Modern Science, by Harold T. Davis, Professor of Mathematics and the Philosophy of Natural Science, Indiana University. Pages xiv + 335, illus. 17, 15 x 22.5 cm. Cloth. The Principia Press, Bloomington, Indiana, 1931. Price $3.50.

Professor Davis states in his Introduction that this book was originally undertaken to prove to a friend that there is much that is poetical in the story of modern science. I have no doubt but that he has succeeded in this undertaking, unless there is something wrong with the friend. Being wise enough to realize that the beauty, the romance and the grandeur of physical science is in the science itself and is not to be gotten simply by rhapsodizing *about it,* Professor Davis gives us a sound, well-integrated and remarkably comprehensive non-mathematical exposition of the rise of modern physics and of the nature of the fundamental physical concepts that can be understood by any intelligent, educated layman. He writes beautifully, with the sensibilities of a poet and the sober, mature understanding of a mathematician and philosopher, and he does not resort to cheap journalism, sentimentality and tiresome superlatives in order to achieve his purpose.

The author has no pet physical or metaphysical theory to propound. He is, however, very much concerned with demonstrating the important fact that there is much more metaphysics in that which we call physics than is suspected even by many physicists. In the past especially, physicists have either fought shy of this idea or have ignored it. Ernst Mach was one of the few who refused to do this, but even to this day Mach has not received the recognition among physicists that he so richly deserves.

It seems to me that never more than today has physical science so needed the assistance of the philosopher. Nor has there ever been a time when science has provided the metaphysician and the epistimologist with so much valuable raw material for real philosophic progress. The trouble is that little is being done about it, probably because there are few philosophers who have been able to keep up with modern physics, and few physicists who know anything about philosophy. I was much amazed to hear Bertrand Russell say recently that in England, where one might expect to find some activity of this kind, there has as yet been no organized attempt on the part of philosophers and physical scientists to attack jointly the immensely important and very fundamental borderland problems to which the new physics has given rise.

Professor Davis makes us of the historical method of approach. He quotes liberally from the classics of both science and general literature.

and in the numerous footnotes he relies for references on original papers and treatises, and not on second-hand sources. To obtain an idea of how comprehensive his treatment is, note some of the chapter titles: Is there an ether?; what is gravitation?; is nature finite?; the atom concept; the laws of chance; the metaphysics of the quantum theory and wave mechanics; the discovery and interpretation of cosmic radiation. Here we have then in one book an introduction to the philosophical problems of physical science, an excellent brief history and survey of modern physical theory, and an exposition of the esthetic qualities of the science; what more could one ask for in a book of this kind? If you are one of those who still think of physics in terms of nineteenth century mechanism at its worst or who has been so unfortunate as to have been raised on the engineering-type of elementary textbook, which savors too much of grease and cogwheels and all the different kinds of pumps, then by all means get this book and read it.

DUANE ROLLER

General Science for Today, by Ralph K. Watkins, Professor of Education, University of Missouri; Ralph C. Bedell, Teacher of General Science, Southwest High School, Kansas City, Missouri. Cloth. Pages xiv + 653. 13 x 19.5 cm. 1932. The Macmillan Company, 60 Fifth Avenue, New York, N.Y. Price $1.66.

Watkins and Bedell, have made a conspicuously valuable contribution to modern education. For some time I have been nothing, in courses of study and in prefaces of textbooks, the general objectives for education and the special objectives for the various school subjects. It is of interest to observe the emphasis given to the usefulness of schooling, as expressed in the statements of these objectives. It is a keen disappointment to observe the extent to which authors are slaves to tradition, as indicated by courses of study and contents of texts.

But Watkins and Bedell have done much better. Little is said about objectives. One may find inconspicuously expressed in the Preface: "Throughout, an attempt is made to help boys and girls build up better understandings of large ideas in science . . . in order to see what is going on all about us." These two authors see boys and girls to be helped rather than general science to be presented. This would be a trite statement save that, quite divergent from other texts, these authors actually carry out this objective.

The fourteen "Units" of work are a unique organization of subject-matter. The thirty-four "Chapters," as subdivisions, are a compromise with tradition. But the organization is subservient to the content. After six interesting pages about the nature of the air and atmospheric pressure, the authors plunge jovially into a presentation of "Man's Control of Atmospheric Pressure." "Air is useful in many machines. Our motor cars ride on it,—and it enables us to drink soda through a straw." In Chapter V, the authors lead the pupils to see "How Water is Used to do Work." Unit VII, "The Forces of Nature as they are found on the Earth," is composed of three chapters, in which such forces as gravitation, motion, energy, are studied as they help people when brought under control by "simple" and "complex" machines. Heat, light, electricity, sound, are treated, not as four chapters in physical science, but as a story of how energy is controlled for its service to mankind. Thus through physical, biological, astronomical realms, these authors lead their pupils into an appreciation of the interrelationship of man and his multiform environment—650 pages filled full of vital information.

The method in this text is unique. This text is in reality a "work-book," without being thus labelled. At the close of each chapter is a list of "Activities," intimately contributing to the full, rich life of young people. The information in each chapter is supplied to help in these activities. Not learning by doing, but learning for the purpose of doing, is here emphasized.

The book is untainted by the traditions of school texts. The authors apparently felt perfectly free to help young people to become acquainted with the simple but fundamental facts in science relating to everyday life. Science is presented not because there are such facts, but because there are young people who may profit by an understanding of those facts.

J. L. MERIAM

Standards for High School Teaching, Methods and Technique, by Charles Everand Reeves, Ph.D., Professor of Education, Elmira College, Elmira, New York. Pp. xiv plus 558. 14 x 19 x 3.5 cm. 1932. D. Appleton and Company, New York. Price $2.50.

"A Complete summary of criteria for evaluating specific methods and techniques of teaching as these procedures affect pupil learning." This is a very strong statement but the book surprisingly lives up to it. It is to be used in conjunction with a work book and is prepared to aid in guiding students in observation of teachers at work and themselves in their practice teaching. A number of definite problems are presented each of which includes reasonable and necessary standards of achievement. Organization of the book is logical and concise. The Table of Contents is very helpful in finding any particular problem desired. The problems are classified into groups. Twelve pages are taken up by the Index which is a further aid to anyone seeking help regarding a difficulty. The chapters are well suported by additional reading lists that the author has apparently examined and used and furnish excellent supplementary reading if desired. Briefly, this is a catalogue of the countless problems that confront the teacher, and with each there is a—what to be, or what to do.

JOSEPH J. URBANCEK

The Teaching of Elementary Mathematics, by the late Professor Charles Godfrey, formerly Senior Mathematical Master at Winchester College and Head Master of the Royal Naval College, Osborne, and A. W. Siddons, late Fellow of Jesus College, Cambridge, and Senior Mathematical Master at Harrow School. Cloth. Pages 11 + 322. 12.5 x 20 cm. 1931. University Press, Cambridge, London. The Macmillan Company, New York. $2.50.

This is an interesting collection of articles, some new and some old, by two noted teachers in English schools. There are chapters dealing with such topics as Aims in Teaching Mathematics, The Importance of Planning a Lesson, Speed and Accuracy in Arithmetic Work, Significant Figures, Degree of Accuracy, The Early Stages of Teaching Algebra, Hypothetical Constructions in Geometry, and other interesting questions. The book contains many stimulating sentences like: Boys are sent to school in order that they may make intellectual efforts, and Algebra is perhaps the mathematical subject which gives the smallest return for the time spent on it.

The text differs from most American texts on teaching in that it discusses in detail methods for teaching many particular rules and theorems instead of only general methods of teaching. Any teacher of high school

mathematics will find in this book many suggestions that can be put into immediate use in the classroom.

JOSEPH A. NYBERG

Teaching the Primary Grades, by Dorothy Bildersee, Principal in the New York City Public Schools. Cloth. Pages xix + 332. 13.5 x 19 cm. 1932. D. Appleton and Company, 35 West 32nd Street, New York, N.Y. Price $2.00.

There are a number of books which deal with the teaching of one particular subject or other in the primary grades. These are valuable for one who wishes to make an intensive subject study. This book, however, should prove a practical aid to the student who must obtain a general view of primary teaching and specific details as to how to proceed, not only in the teaching of one subject, but in all the subjects of the first three grades. It should give the primary teacher, who is already in the field and aware of her problems, definite helps in solving those problems.

Teaching in the Primary Grades is not the work of a theorist, but rather the scholarly presentation of primary teaching by one who understands in a practical way the problems of the classroom teacher. First, in this book, there is a discussion of the newer, more progressive tendencies in education and the child psychology upon which they are based. Chapters II through VII give a comprehensive treatment of the teaching of reading. The author begins with the general underlying principles of reading and discusses in turn, aims and practices in the first year, then in the second and third years. The need for, and the best methods of developing speed an comprehension in silent reading are treated in Chapter V. The acquisition of skill in the mechanics of reading, and diagnostic and remedial work are each given a chapter. Three chapters are then given to the discussion of oral and written composition and the development of techniques of expression. Chapters XI-XV discuss arithmetic, the concepts of number and the specific steps in the teaching of arithmetical processes together with diagnostic testing and remedial measures. In Chapter XVI, health education is treated in such a way that the reader is made conscious of physical defects common in young children and the corrective measures which may be carried out by the teacher. One chapter is given to the aims, methods of handling and the results to be expected in the teaching of Art and Music in these early grades.

In general one might say that each subject is treated as to its underlying psychology, its aims and the difficulties it presents together with details of teaching method, diagnostic tests and remedial procedures. This book seems to fill a long-felt need as a handbook for those interested in primary teaching. It is well organized, clear, easy to read, and above all, practical.

MARGARET URQUHART

Physics for Secondary Schools, by Oscar M. Stewart, Professor of Physics, University of Missouri, Burton L. Cushing, Head of the Department of Science, East Boston High School; Judson R. Towne, Teacher of Physics, John Marshall High School, Minneapolis. Cloth. Pages viii + 736. 13 x 19.5 cm. 1932. Ginn and Company, 15 Ashburton Place, Boston, Mass. Price $1.72.

The authors of this text have been leaders in physics instruction for years. Evidently the book is a composite of their judgments and experiences. They do not claim to have revolutionized the method of presentation; they admit the influence of the many years of standardization and

of college requirements. The book is divided into *units* but a unit here means merely one of the major divisions of the subject, and is not used in the technical sense of recent educational terminology. Each unit is preceded by a "foreword" or "Preview"; each chapter opens with a short series of thought-stimulating questions which aim to give the pupil some motive for reading the chapter. The aim has been to start each chapter with specific material and by careful choice of language to lead the pupil to an understanding of the general principle which is the theme of the chapter. Each chapter closes with a brief summary, a list of questions on the chapter, a set of numerical problems, and a list of topics and questions for investigation by students having time and ambition to do superior work.

Frequently throughout the book sections are starred, indicating that such sections may be omitted by students not preparing for college. The starred sections number 83 out of a total of 454 sections or about 18 per cent. Most teachers agree that the ordinary textbook of physics contains entirely too much subject matter even for the classes above average. We might first ask if the starring has gone far enough. Can the average student master 80 per cent of the average text? If not, the final selection is still left to the teacher or pupil. The reviewer is in complete agreement on most of the starred sections but was startled to find the topic on density in the list. Other questions might be raised on the selection. On the other hand the text could be improved by further use of the blue pencil in some sections. An explanation which does not explain should be eliminated. Examples are the cause of thunder on page 387 and the explanation of a mirage on page 617.

But it is easy to find fault. The reviewer is well pleased with the book and believes the authors have accomplished their primary aim of producing a text that is understandable. The discussions of electrical theory, structure of matter, etc. are modern. The book is exceptionally free from the usual errors of a first edition. When a change of text is contemplated this one should receive consideration. It at least outranks many that have appeared and will be approved by conservative teachers.

G.W.W.

Everyday Problems in Biology, by Charles J. Pieper, New York University; Wilbur L. Beauchamp, University of Chicago; and Orland D. Frank, University High School, Chicago. xxxiii + 686 pp. 475 figures. Scott, Foresman and Company, 1932. $1.60.

This is a real general biology in that it is based on the principles of life as they can be illustrated by plants and animals in approximately equal proportion. It is not a mass of unrelated facts about living things. The pupil is led to form clear-cut ideas about activities, processes, and relationships of plants and animals that form a background for desirable attitudes toward the things of nature and a real foundation for the science work which is to follow.

The book is built around the unit-problem plan of organization by experts in this type of course construction. There is no better aid for those teachers who want an outstanding example of the possibilities offered by the unit method of organization. The central idea of each division is not only named in bold letters at the top of every other page, but it sticks out all the way through the division.

Student helps are given in a sixteen page introductory message, preliminary exercises and the story of the unit in each case, and study suggestions scattered through the context. A glossary and pronunciation list

The Ever-useful Workbook

in Science

BROYLES AND WILSON Workbook for Students in Poultry Husbandry $0.80 (prices subject to discount)

ADELL, DUNHAM, AND WELTON A Biology Workbook $1.32. Accompanying Tests 10 copies of each of 23 tests, per package $2.40

MEIER Biology Notebook To accompany "Essentials of Biology" $0.72

McPHERSON, HENDERSON, FOWLER A Laboratory Workbook To accompany "Chemistry for Today" $0.76

CALDWELL AND CURTIS Workbook to accompany "Introduction to Science" $0.72

CUSHING Directed Studies for the Physics Laboratory To accompany Stewart, Cushing, Towne's "Physics for Secondary Schools" $0.76

in Mathematics

SMITH, REEVE, MORSS Exercises and Tests in Algebra through Quadratics, $0.60; Brief Edition of same, $0.40; Exercises and Tests in Plane Geometry, $0.48; Exercises and Tests in Junior High School Mathematics. In two parts, each $0.48

Ginn and Company

Just Out **Something New**

A most useful and entertaining book entitled

Mathematical Nuts

A COMPANION VOLUME TO "MATHEMATICAL WRINKLES"

Consisting of Gems in Mathematics—Brain Teasers, Thought Provoking Questions, Recreations, and Interesting and Stimulating Problems in Arithmetic, Algebra, Plane Geometry, Solid Geometry, Trigonometry, Analytics, Calculus, Physics, etc. It contains nearly 200 illustrations and more than 700 solutions.

Sections

1. Nuts for Young and Old.
2. Nuts for the Fireside.
3. Nuts for the Classroom.
4. Nuts for the Math Club.
5. Nuts for the Magician.
6. Nuts for the Professor.
7. Nuts for the Doctor.
8. Nuts, Cracked for the Weary.
9. Nut Kernels.
10. Index.

A Source Book for Teachers. The Book for the Math and Science Club. Beautifully bound in half leather and attractively illustrated.

"Every teacher of Mathematics or Physics should have this book."—School Science and Mathematics

Order Today! Postpaid to any address $3.50

Special Offer—A copy of this book and a copy of Mathematical Wrinkles (1930 Edition. Rev. & Enl., $3.00) will be sent on receipt of $6.00.

S. I. Jones Author & Publisher Life and Casualty Bldg. **Nashville, Tenn.**

is given at the end of the book. The diction and language are admirably suited to the pupil-level for which the book is intended. Abundant material is offered in the form of exercises for the whole class and there are also activities suggested for the use of pupils who are able to do more than the average amount of work.

The book is unique in the originality and excellence of the illustrations. It is attractively bound, and the mechanical make-up and quality of paper and printing are all that could be desired.

JEROME ISENBARGER

BOOKS RECEIVED

Recent Developments in the Teaching of Geometry, by J. Shibli, The Pennsylvania State College. Cloth. Pages x + 252. 13.5 x 20.5 cm. 1932. J. Shibli, Publisher, State College, Pennsylvania. Price $2.25.

Solid Geometry, by Herbert E. Hawkes, Professor of Mathematics in Columbia University; William A. Luby, Head of the Department of Mathematics in the Junior College of Kansas City; Frank C. Touton, Professor of Education in the University of Southern California. New Edition. Cloth. Pages xvi + 216. 12.5 x 19 cm. 1932. Ginn and Company, Number 15 Ashburton Place, Boston, Mass. Price $1.24.

Mathematics of Finance, by H. L. Rietz, University of Iowa; A. R. Crathorne, University of Illinois; J. Chas. Rietz, Actuary of the Midland Mutual Life Insurance Company. Revised Edition. Cloth. Pages xv + 346. 12.5 x 19.5 cm. 1932. Henry Holt and Company, One Park Avenue, New York, N.Y. Price $3.00.

Everyday Problems in Biology, by Charles J. Pieper, New York University; Wilbur L. Beauchamp, University of Chicago; Orlin D. Frank, University High School, Chicago. Cloth. Pages xxxiii + 686. 13 x 19 cm. 1932. Scott, Foresman and Company, 623 South Wabash Avenue, Chicago, Ill. Price $1.60.

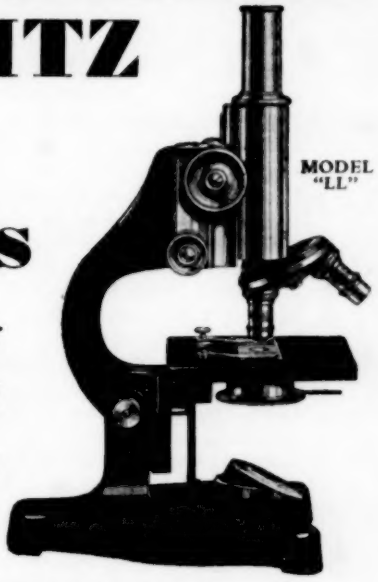
The Beginnings of the Social Sciences, by Mary M. Reed, Assistant Professor, Department of Nursery School, Kindergarten-First Grade Education, Teachers College, Columbia University; Lula E. Wright, The Lincoln School of Teachers College, Columbia University; Introduction by Patty Smith Hill, Director of Department of Nursery School, Kindergarten-First Grade Education, Teachers College, Columbia University. Cloth. Pages xxxiv + 224. 12.5 x 19 cm. 1932. Charles Scribner's Sons, 597 Fifth Avenue, New York, N.Y. Price $1.50.

Out of Doors, A Guide to Nature, by Paul B. Mann, Associate in Education, American Museum of Natural History, Head of Department of Biology, Evander Childs High School, New York City; George T. Hastings, Faculty Member of Nature Camp, Pennsylvania State College, Head of Department of Biology, Theodore Roosevelt High School, New York City. Cloth. Pages x + 448. 12.5 x 19 cm. 1932. Henry Holt and Company, One Park Avenue, New York, N.Y.

An Investigation of Content and Mastery of High School General Science Courses, by Elwood D. Heiss, Head of the Department of Science, State Teachers College, East Stroudsburg, Pennsylvania. Cloth. 118 pages. 15 x 23 cm. 1932. Elwood D. Heiss, East Stroudsburg, Pennsylvania. Price $1.50.

The Elements of Physics, by Alpheus W. Smith, Professor of Physics, The Ohio State University. Third Edition. Cloth. Pages xviii + 778. 14 x 23 cm. 1932. McGraw-Hill Book Company, 330 West 42nd Street, New York, N.Y. Price $3.75.

The New LEITZ School Microscopes



offer at a low price many of the optical and mechanical refinements found only in more expensive instruments.

Here Are the Features of MODEL "LL":

Body Tube

Is of 35 mm diameter; stationary pattern (if desired, adjustable draw tube will be furnished without charge).

Focusing Adjustment

Coarse adjustment is by rack and pinion. The fine adjustment consists of a sensitive and precise but extremely rugged micrometer screw to withstand rough handling to which microscopes in routine laboratory work or student's use are naturally subjected; a safety device is provided to prevent injury to specimens and objectives. One micrometer head is equipped with divided drum with vernier which records the vertical displacement of the microscope tube within 0.004mm and consequently permits accurate measurements of the thickness of specimens.

Stage

Of metal, completely covered with vulcanite, measures 114 x 114mm, provided with stage clips. The sleeve beneath the stage carries a cylinder iris diaphragm situated in the plane of the stage.

Substage

In withdrawing the cylinder iris diaphragm, the stage sleeve is available for the adaptation of divisible substage condensers, with iris diaphragm attached.

Base, Pillar and Arm

The *base* is of modified horseshoe form, measuring 170mm from tip to heel. The *pillar* has a double joint and friction device to hold stand at any desired angle while stops are provided for horizontal and vertical positions. The *arm* is of exceedingly heavy and curved form, providing ample space for large specimens.

Finish

In alcohol-proof lacquer throughout.

Cabinet

Hardwood, highly polished, with lock and key.

Wide Range of Equipment

to meet all study requirements.

Prices

$47.75 to $113.50, depending on equipment. 10% educational discount.

Write for Pamphlet No. 1168

E. LEITZ, Inc., Dept. 161, 60 East 10th St., New York

Branches: Washington, D.C., Chicago, Ill., San Francisco and Los Angeles, Calif.

Hygiene, A Textbook for College Students with Sections on Anatomy and Physiology, Pathological Conditions, and Mental Hygiene, by Florence L. Meredith, Professor of Hygiene, Tufts College, Lecturer on Hygiene, Simmons College. Second Edition with 230 Illustrations. Cloth. Pages xii + 802 + 35. 14 x 21 cm. 1932. Blakiston's Son and Company, Inc., 1012 Walnut Street, Philadelphia, Pennsylvania. Price $3.50.

Physics for Secondary Schools, by Oscar M. Stewart, Professor of Physics, University of Missouri; Burton L. Cushing, Head of the Department of Science, East Boston High School; Judson R. Towne, Teacher of Physics, John Marshall High School, Minneapolis. Cloth. Pages viii + 736. 13 x 19.5 cm. 1932. Ginn and Company, 15 Ashburton Place, Boston, Mass. Price $1.72.

Physics, for Students of Science and Engineering. Mechanics and Sound, by A. Wilmer Duff (Editor); Wave Motion and Light by E. Percival Lewis and Revised by R. T. Rirge and E. E. Hall; Heat by Charles E. Mendenhall; Electricity and Magnetism by Albert P. Carman and C. T. Knipp. Seventh Revised Edition. 630 Illustrations. Cloth. Pages xiv + 681. 14 x 21.5 cm. 1932. P. Blakiston's Son and Company, Inc., 1012 Walnut Street, Philadelphia, Pa. Price $4.00.

General Science for Today, by Ralph K. Watkins, Professor of Education, University of Missouri; Ralph C. Bedell, Teacher of General Science, Southwest High School, Kansas City, Missouri. Cloth. Pages xiv + 653. 13 x 19.5 cm. 1932. The Macmillan Company, 60 Fifth Avenue, New York, N.Y. Price $1.66.

Introduction to Trigonometry and Analytic Geometry by Ernest Brown Skinner, Professor of Mathematics, The University of Wisconsin. Cloth. Pages xi + 189. 12 x 19 cm. 1932. The Macmillan Company, 60 Fifth Avenue, New York, N.Y. Price $1.80.

Recent Advances in Cytology, by C. D. Darlington, D.Sc., Ph.D., Cytologist, John Innes Horticultural Institution. Cloth. 8 Plates, 109 Textfigures and 66 Tables. Pages xviii + 559. 13.5 x 20 cm. 1932. P. Blakiston's Son and Company, Inc., 1012 Walnut Street, Philadelphia, Pa. Price $4.00.

Manual of Animal Biology, by George Alfred Baitsell, Professor of Biology in Yale University. Cloth. Pages xiii + 382. 14 x 21.5 cm. 1932. The Macmillan Company, 60 Fifth Avenue, New York, N.Y. Price $2.50.

Methods in Plant Histology, by Charles J. Chamberlain, Professor Emeritus of Morphology and Cytology in the University of Chicago. Fifth Revised Edition. Cloth. Pages xiv + 416. 14.5 x 22 cm. 1932. The University of Chicago Press, Chicago, Illinois. Price $3.25.

Laboratory Manual to Accompany Introductory General Chemistry, by Harold G. Dietrich and Erwin B. Kelsey, Assistant Professors in Chemistry, Yale University. Cloth. Pages x + 73. 1932. The Macmillan Company, 60 Fifth Avenue, New York, N.Y. Price $1.00.

Fundamentals of Physical Chemistry, by Earl C. H. Davies, Professor of Physical Chemistry at West Virginia University. Cloth. 78 Illustrations. Pages vii + 370. 14 x 21.5 cm. 1932. P. Blakiston's Son and Company, Inc., 1012 Walnut Street, Philadelphia, Pa. Price $2.75.

Projective Differential Geometry of Curves and Surfaces, by Ernest Preston Lane, Professor of Mathematics in the University of Chicago. Cloth. Pages xi + 321. 16.5 x 24.5 cm. 1932. The University of Chicago Press, Chicago, Illinois. Price $4.00.

Elementary Differential Equations, by Lyman M. Kells, Assistant Professor of Mathematics at the U. S. Naval Academy. First Edition. Cloth. Pages ix + 184. 13.5 x 20.5 cm. 1932. McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York, N.Y. Price $2.00.

An Immediate Success

MASTERY UNITS IN PHYSICS

UNIVERSITY OF CHICAGO—". . . the best example to date of the organization of material for the teaching of physics in accordance with the unit conception."

Henry C. Morrison.

NEWARK, N.J.—". . . one of the best that I have seen."

J. E. Sinclair, Central Commercial and Manual Training High School.

SACRAMENTO, CALIF.—". . . the authors have produced a very fine and useful book."

G. C. Hensen, Assistant Superintendent for Secondary Schools.

INDIANAPOLIS, IND.—". . . comes as near fulfilling my idea of a textbook for physics students as any I have examined."

L. S. Mills, Ben Davis High School.

MADISON, WIS.—"*Mastery Units in Physics* was adopted by the Madison schools for the following reasons:

(1) Because of its wide range of adaptability, meeting the needs of the students who wish to prepare for college, as well as those who desire an informational course in physics."

(2) Because it includes material beyond a mediocre class level and thus placed no penalty on intelligence.'

(3) Because it recognizes that physics deserves a certain amount of mathematical treatment which the text offers without apology."

(4) Because instead of avoiding difficult topics it undertakes the more difficult task of clear explanations."

F. William Schuler, West High School.

MASTERY UNITS IN PHYSICS

Holley-Lohr

$1.88 List

Have you seen *Mastery Units in Physics?* If you have not seen *Mastery Units in Physics* and wish to consider it for your classes, send us the upper half of this page, with your name, teaching address, and the probable date of adoption. We shall be glad to send you an examination copy.

J. B. LIPPINCOTT COMPANY

1249-1257 South Wabash Avenue, Chicago

Please Mention *School Science and Mathematics* when answering Advertisements

Recent Advances in Atomic Physics, by Gaetano Castelfranchi, Professor in the High School for Engineers in Milan; Approved Translation by W. S. Stiles, Scientific Assistant, The National Physical Laboratory, Teddington and J. W. T. Walsh, Principal Assistant, The National Physical Laboratory, Teddington. Volume I, Atoms, Molecules and Electrons. Cloth. Pages xii + 360 + 12, 111 Illustrations. 13 x 20 cm. 1932. P. Blakiston's Son and Company, Inc., 1012 Walnut Street, Philadelphia, Pa. Price $4.00.

Recent Advances in Atomic Physics, by Castelfranchi, Professor in the High School for Engineers in Milan; Approved Translation by W. S. Stiles, Scientific Assistant, The National Physical Laboratory, Teddington and J. W. T. Walsh, Principal Assistant, The National Physical Laboratory, Teddington. Volume II, Quantum Theory. Cloth. Pages xii + 400 + 12. 79 Illustrations. 13 x 20 cm. 1932. P. Blakiston's Son and Company, Inc., 1012 Walnut Street, Philadelphia, Pa. Price $4.00.

Appleton's Standard School Atlas, edited by George Philip, F.R.G.S. and V. C. Finch, Professor of Geography in the University of Wisconsin. Cloth. Pages xxviii + viii + 63. 22.5 x 28 cm. 1932. D. Appleton and Company, 35 West 32nd Street, New York, N.Y. Price $1.50.

Essentials of College Chemistry, by B. Smith Hopkins, Professor of Inorganic Chemistry in the University of Illinois. Cloth. Pages vi + 544. 14 x 21.5 cm. 1932. D. C. Heath and Company, 285 Columbus Avenue, Boston, Mass. Price $3.24.

PAMPHLETS RECEIVED

An Analytical Study of Mathematical Abilities, by George Joseph Cairns, A.M., S.T.B. of St. Mary College and Academy, Monroe, Michigan. 104 pages. 15 x 23 cm. 1931.

President's Report and Catalogue of Pupils, Girard College, The City of Philadelphia, Trustee. 130 pages. 15 x 23 cm. 1931.

Opportunities for the Preparation of Teachers of Exceptional Children, by Elsie H. Martens, Senior Specialist in the Education of Exceptional Children, Office of Education. Bulletin No. 21, 1931. Pages iii + 42. 15 x 23 cm. Superintendent of Documents, Washington, D.C. Price 5 cents.

Proceedings of the Fourth National Conference on Vocational Rehabilitation of the Disabled Civilian. Civilian Vocational Rehabilitation Series No. 14. Bulletin No. 121. June 1927. Pages xiii + 144. 14 x 23 cm. Superintendent of Documents, U. S. Government Printing Office, Washington, D.C. Price 25 cents.

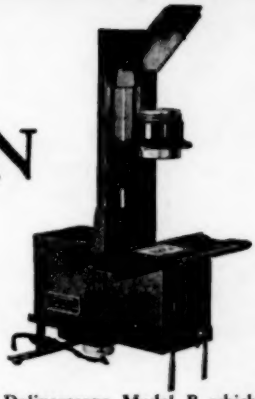
Vocational Guidance in Rehabilitation Service. Vocational Rehabilitation Series No. 20. Bulletin No. 148. June 1930. Pages xii + 56. 15 x 23 cm. Superintendent of Documents, Washington, D.C. Price 15 cents.

Education in Belgium, by James F. Abel, Chief, Division of Foreign School Systems, Office of Education. Bulletin 1932, No. 5. Pages vii + 145. 14.5 x 23 cm. Superintendent of Documents, U. S. Government Printing Office, Washington, D.C.

The Legal Status of the County Superintendent, by N. William Newsom, Professor of Education Western State College, Gunnison, Colorado. Bulletin 1932. No. 7. Pages vi + 41. 15 x 23 cm. Superintendent of Documents, Washington, D.C.

The History of the Municipal University in the United States, by R. H. Eckelberry, Assistant Professor of History of Education, Ohio State University. Bulletin, 1932. No. 2. Pages viii + 213. 14.5 x 23 cm. Superintendent of Documents, Washington, D.C.

Visual INSTRUCTION *Aids Teaching*



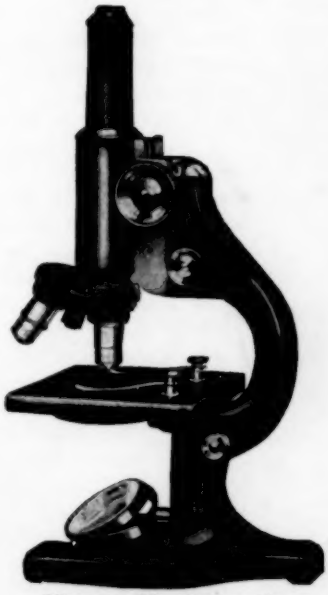
Delineascope Model B which enables the teacher to face his class at all times and project the picture on a screen over his head. Projects glass slides, filmslides or micro-slides.

Whether it be in the laboratory or lecture room, visual instruction makes teaching easier, more complete—and helps reduce the number of student failures.

The microscope is essential in the laboratory —it must be used in teaching biology, botany and zoology.

The value of a projector for the classroom or lecture is not so well known, however. It is valuable in that the same picture can be shown to the entire class at the same time. Students get a "mind picture" of the subject that sticks with them. The subject becomes more interesting when supplemented with visual instruction and students learn more easily.

Write for our folders describing Spencer Microscopes and Delineascopes for use in teaching. Write today!



Microscope No. 64—completely equipped for precise work in elementary courses in science. Simple and durable in construction. A fool-proof microscope for student use.

PRODUCTS: Microscopes, Microtomes, Delineascopes. Visual Aids, Optical Measuring Instruments

BRANCHES: New York, Chicago, San Francisco, Boston, Washington, Minneapolis.

Spencer Lens Company

BUFFALO NEW YORK

The County Superintendent in the United States, by Julian E. Butterworth, Professor of Rural Education, Cornell University. Bulletin 1932. No. 6. Pages v + 50. 15 x 23 cm. Superintendent of Documents, Washington, D.C.

Status of Teachers and Principals Employed in the Rural Schools of the United States, by Walter H. Gumnitz, Senior Specialist in Rural Education Problems, Office of Education. Bulletin 1932. No. 3. Pages iv + 122. 14.5 x 23 cm. Superintendent of Documents, Washington D. C.

Summer Educational Opportunities, by Ella B. Ratcliffe, Chief Educational Assistant, Division of Colleges and Professional Schools, Office of Education. Pamphlet No. 27. Pages iii + 44. 15 x 23 cm. Superintendent of Documents, Washington, D.C.

Brooklyn Botanic Garden Record. May 1932. Vol. xxi. No. 3. 144 pages. 15.5 x 23 cm. Published Bimonthly at Prince and Lemon Streets, Lancaster, Pa., by The Brooklyn Institute of Arts and Sciences. Brooklyn, N. Y.

Binary Logarithms, by G. H. Pohland, 1149 Felton Court, Chicago Illinois. 1931. Mimeographed, 24 pages. 21.5 x 28 cm. Price $2.00.

The International Metric System of Weights and Measures, issued May 26, 1932. 13 pages. 15 x 23 cm. United States Government Printing Office, Washington, D.C. Price 5 cents.

A Curriculum Study of Teacher Training in Arithmetric, by Leo J. Brueckner, Professor of Education, University of Minnesota in cooperation with Leslie D. White and Fred Dickeman. 1932. 28 pages. 15 x 23 cm. University of Minnesota Press, Minneapolis, Minn.

Sabbatical Leave for College Teachers, by Lewis B. Cooper, Assistant Professor of Supervised Teaching. February 1932. Vol. I, No. I. Pages vi + 89 pages. 15 x 23 cm. Published by the University of Florida. Price $1.00.

Physical Education and Health Education as a Part of all General Teacher-Training Curricula, by Marie M. Ready, Associate Specialist in Recreation, Office of Education. Bulletin 1932. No. 10. 47 pages. 15 x 23 cm. United States Department of the Interior, Washington, D.C.

Safety Education Helps for Schools in Constructing a Course of Study, by Florence C. Fox, Associate Specialist in Elementary Education, U. S. Office of Education. Bulletin, 1932, No. 8. Pages iii + 73. 15 x 23 cm. United States Department of the Interior, Office of Education, Washington, D.C.

Health Heroes (Robert Koch), by Grace T. Hallock, Co-Author of *The Land of Health* and Author of other Health Books; C. E. Turner, Professor of Biology and Public Health, Massachusetts Institute of Technology. 1932. 30 pages. 13.5 x 19.5 cm. School Health Bureau, Welfare Division, Metropolitan Life Insurance Company.

The High School Science Library for 1931-32, by Hanor A. Webb, George Peabody College for Teachers, Nashville, Tennessee. 13 pages. 17 x 24 cm. Price 12 cents.

Report on Equipment, Apparatus, and Materials for Teaching Science in the Secondary Schools of Massachusetts, by a Committee, Professor N. Henry Black, Chairman. 43 pages. 14 x 23 cm. 1930.

Die Lichtelektrische Zelle Und Ihre Herstellung, von Richard Fleischer und Horst Teichmann, Assistenten am Physilakalischen Institut Der Technischen Hochschule zu Dresden. 1932. 179 pages. 201 Illustrations. 29 Tables. 15 x 22.5 cm. Theodor Steinkopff, Dresden und Leipzig.

Do You Want Extra Years of Service?

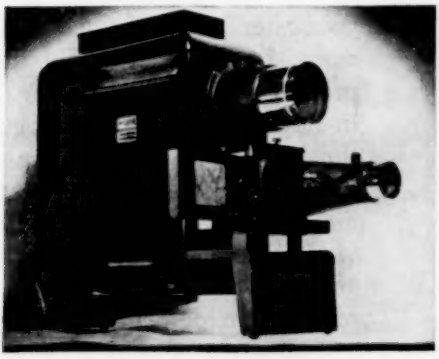
It's extra years of service that make B&L products such outstanding value. Years of experience in building to exacting school requirements and the finest care in selecting materials and in manufacture are reasons why the B&L label stands as a safe indication of true value.

The FS Microscope, for example, is the standard instrument in laboratories of secondary schools. Ruggedly built to stand all sorts of hard knocks from inexperienced students, yet so finely made that it easily meets the requirements of advanced students. A wide range of accessories are available.

The LRM Balopticon is a dual purpose instrument that makes visual instruction thoroughly practical in classrooms or lecture halls for all subjects. By virtue of its structural ruggedness and operating simplicity it can be so quickly set up and so efficiently run as to conserve both teaching time and effort. *Projects either slides or opaque objects.*

Send coupon for complete details.

The FS Microscope



The LRM Balopticon

BAUSCH & LOMB OPTICAL COMPANY

687 St. Paul Street Rochester, N.Y.

Please send me complete details—

FS MICROSCOPE LRM BALOPTICON

Name .....

Address .....

City ..... State .....

LEARNING THE ELECTRIC MOTOR

By Joseph Singerman
James Monroe High School, New York City

Not among the simple things to get across to high school physics students, and especially to general science students, is the principle of the D.C. motor. Several methods are employed in teaching this topic. Some teachers combine teacher-demonstration work with individual laboratory work. Sometimes the latter is omitted. In connection both with the demonstration and with the laboratory work, a bi-pole armature motor is particularly well suited to the task, and such a motor is almost always used. A device like the motor remains, I am convinced, a more or less abstract affair in the minds of many students, even after a laboratory experience with one. Teaching the motor principle is a fair piece of work for the teacher, and sometimes a distasteful experience on the part of the recipients.

The writer has witnessed expressions of pride and delight in the occasional student who brings in a crude motor of his own design and construction. There is no question that this youngster learned not only the motor principle, but much more, both mechanically and psychologically. The teacher proudly displays the object of joy, feeling a keen satisfaction in having aroused in one youngster enough interest and enthusiasm to initiate such a project. I have often felt that I should like to inspire similar activity among those in the remaining group of students. The passive state of mind, so obvious among many of our students, may be attributed in a general way to the following circumstances. Due to conditions of past environment or education, the individual never acquired a realization of and a confidence in his own potential power and ability to construct things. Thus he has come to lack initiative and self-reliance. However, make it possible for the student to make a motor, convince him that he can do it, and he will learn its principles through his own experience. Psychological by-products of the process will accrue to him as well. In the case of the motor the problem was solved for me by a chance experience.

A toy sold in the five and ten cent store came my way. It was a small paper box containing all parts necessary to build

Fractional, Zero and Negative Exponents

ALGEBRA TEACHERS,
here is a treatment of this troublesome topic that will eliminate the difficulties—a special pamphlet that teaches the subject. Put it into the hands of your pupils. Price 25 cents; write for special quotation on quantities.

SCHOOL SCIENCE AND MATHEMATICS
3319 N. Fourteenth St.
Milwaukee, Wis.

USEFUL PLANTS OF THE WORLD

by Willard N. Clute

Second edition, 234 pp. $3.75

Books by the Same Author

Common Names of Plants, 164 pp.	$3.00
Swamp & Dune, illust., 90 pp.	$1.50
Botanical Essays, 107 pp.	$1.75

A subscription to American Botanist for $1.25 additional

WILLARD N. CLUTE & CO.
Indianapolis, Ind.

1932 EDITION

A General Science Workbook

Lake-Welton-Adell

With the addition of new problems, A GENERAL SCIENCE WORKBOOK becomes a more effective classroom force than before. Teachers who have not yet brought this great learning aid into their classes should examine this new, improved edition. The many teachers now using the workbook will wish to have the new edition for use this year. List price, $1.00.

A TEACHERS BOOK is now published. Accurate checking and grading of all the work done by students can be accomplished more quickly and easily through the use of this book. List price, $.60.

Objective tests on the sixteen units of A GENERAL SCIENCE WORKBOOK are also available, with key.

Silver, Burdett and Company
New York Newark Boston Chicago
San Francisco

Books and Tests for the Science Teacher

THE INTRODUCTORY BIOLOGICAL SCIENCES IN THE LIBERAL ARTS COLLEGE. By GEORGE E. NELSON, PH.D. A discussion of whether or not introductory courses in the biological sciences give adequate consideration to the needs of a liberal education. Included is a number of comprehensive examinations for the field of introductory biology which should prove valuable to teachers. 135 pp. Cloth, $1.50.

COURSE OF STUDY IN ELEMENTARY SCIENCE FOR HORACE MANN SCHOOL, GRADES I TO VI. By GERALD S. CRAIG. A course of study embodying modern developments in elementary science and suggesting what to teach and how to teach it. In three separate paper bound booklets: Grades I and II, 91 pp.; Grades III and IV, 126 pp.; Grades V and VI, 121 pp.; 90 cents each.

FINAL TEST IN HIGH SCHOOL PHYSICS. By A. W. HURD. Three equivalent forms, A, B, and C, manual of directions, and key. Measures achievement of pupils in physics, estimates efficiency of instruction, and forecasts a student's probable success in college courses in physics and engineering. Price, $2.00 per 100. Specimen set, 10 cents.

POWERS GENERAL SCIENCE TEST. By SAMUEL R. POWERS. Two equivalent forms, A and B, directions, and scoring sheet. Designed to measure range of information in science for Grades 7 to 9 and high school general science classes. Price, $2.00 per 100. Specimen set, 10 cents.

TEST OF GENERAL BIOLOGY. By MERVIN E. OAKES and SAMUEL R. POWERS. Two equivalent forms, A and B, directions, and scoring sheet. A test for high school grades which measures range of information of the facts and principles of biology, including the ability to apply them to concrete situations. Price, $2.00 per 100. Specimen set, 10 cents.

Bureau of Publications, Teachers College
Columbia University, New York City

a motor. Directions were included, as was also an explanation of the motor principle. I turned it over to one of my boys with a remark to "make it." He made it, and it worked. That sample sold practically the entire class to the idea. They assembled their motors at home. On a day designated, all motors appeared in school, the electricity was supplied, and we had a laboratory exercise. The review in class the following day consisted largely in having some students report to the class, if possible, why their motors failed at first to function and how they were repaired or adjusted. There were difficulties due to the following causes (It may be well, during the laboratory period, to list them on the blackboard together with possible remedies):

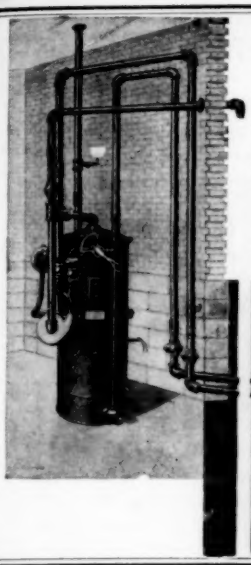
1. Failure to scrape the enamel off the commutator segments.
2. Enamel scratched off where wire was drawn around sharp edges.
3. Wrong position of commutator segments.
4. Too much brush friction.
5. Failure to scrape enamel off wire where connection is made to brushes.
6. Two like poles on the armature.
7. Too much bearing frictoin due to setting end brackets too close.
8. Lack of brush contact.

If carefully constructed the motor will operate on a good dry cell. In that case it will draw an instantaneous current of about 6 amperes, and will register about 1 or 1½ amperes while running. The writer recommends as an alternative a common current supply from a few storage cells connected up in parallel (2 volts). The storage cells, if too few or of too low capacity may be placed on charge while in use, at a rate preferably around half the possible demand. For maximum success it is recommended that the instructor acquaint himself thoroughly with the motor and its possibilities.

After having tried this method, the following appeared quite evident to the writer:

1. Students learned the motor principle more readily than by any of the old methods.
2. Less energy was expended by the teacher.
3. Students enjoyed the process immensely.

It is also an opinion of the writer that the knowledge thus gained will not easily be forgotten by the student.



ELECTRICALLY OPERATED
AUTOMATIC GAS MACHINE
Requires No Attention

Write to us for list of colleges and high schools using our machine. Illustrated Catalogue Will Be Sent on Request.

MATTHEWS GAS MACHINE COMPANY
192 N. Clark Street **CHICAGO, ILL.**

This Machine Will
Automatically
Produce

GAS

For your laboratories and Domestic Science Department.

In use in hundreds of educational institutions throughout the country.

ADVERTISING PAYS

When your ads are run regularly in SCHOOL SCIENCE and MATHEMATICS
Our Rates are low. Compare them with other educational journals.
We reach the buyers of scientific apparatus and books.
Reserve space and send copy for our next issue to
SCHOOL SCIENCE AND MATHEMATICS **3319 N. 14th St., Milwaukee, Wis.**
W. F. Roecker, Bus. Mgr.

Attention, Biology Teachers

Our latest reprint is entitled

Some Lessons About Bees

By C. P. WEBSTER
Allegheny Vocational School, N.S., Pittsburgh, Pa.

A 32-page booklet by an expert on bees; it teaches the mysteries of bee life. Long enough to cover essentials; short enough for a unit, or project. Well illustrated. Valuable for supplementary work. Get a set of 30 for your library.

Price—40c; in 15 lots, @ 30c; in 30 lots, @ 25c.

Order prepaid, net; prompt delivery

SCHOOL SCIENCE AND MATHEMATICS
3319 N. 14th St., **Milwaukee, Wis.**

Public Education — America's Greatest Business

No slump here. The schools are going stronger than ever before.

One Million Salesman. *Are they selling your goods?*
Thirty Million Customers. *Do they know your products?*

The school population changes rapidly. To be effective advertising must be continuous.

You are not addressing a mass meeting; it is a parade.

PREPARATION OF MANUSCRIPTS FOR PUBLICATION

Many articles come to our editorial office before they have been put in condition for our use. Make your contribution clear even to an editor. Do not expect to correct spelling punctuation and other carelessness when you receive galley proof. The printer charges extra for making all changes not due to errors in type-setting, hence it is very necessary that the original manuscript be exactly right and perfectly clear. Contributors will be assessed for printer's charges for alterations.

Papers for publication should be sent to Glen W. Warner, Editor, 7633 Calumet Avenue, Chicago, Ill. Return postage should be included if the manuscript is to be returned if rejected.

Manuscripts submitted should not have been published elsewhere. They should be original typewritten copies, double- or triple-spaced with wide margins on 8½" x 11" paper.

References and footnotes should be numbered consecutively throughout the article and indicated by superior numbers. The reference or footnote should be set off by rules and placed immediately below the citation.

Drawings should be made on good quality white paper in black India ink. Letters, numbers, etc., which cannot be set in type at the margin of the cut must constitute a part of the drawing. They should be proportioned to insure legibility in the cut.

Read galley proof as soon as received, indicate corrections clearly in pencil and return to the Editor immediately.

BUILDING TRUCK TRAILS IN NATIONAL FORESTS

A mechanical Paul Bunyan, the "bulldozer," is depicted uprooting trees, crashing through impenetrable underbrush, rolling huge boulders from his path, and otherwise cavorting in the irresistible manner word-of-mouth fiction has associated with the Patron of the Lumberjack, in the new United States Department of Agriculture educational motion picture, "Building Truck Trails in the National Forests," a 1-reel, silent film.

This new film depicts the use of modern machinery in the construction of low-cost roads over which men and equipment may be quickly transported to fire locations in the remote sections of the National Forests. It shows how fires spread when unchecked and the greatly increased cost of suppressing them.

A NEW EXPOSURE METER

Light intensity measurement has been placed on the same basis as the measurement of amperes or volts by the Western Electrical Instrument Corporation, using their newly developed Photronic Photoelectric Cell. The latest use to which they have placed this remarkable electric eye, is a Universal Exposure Meter for photographic use, in which brightness measurements are taken directly from the scale of an instrument easily read by the layman.

This Exposure Meter is scientifically designed to give accurate exposure information for both "stills" and "movies." It consists essentially of two parts, (1) an electrical instrument operating from two Photronic Photoelectric Cells located in the back of the meter and (2) a simple, novel mechanical calculator for translating the brightness measurements into proper apertures and shutter timings for any plate or film speed.

It is always ready for use as no batteries are required and no adjustments necessary. It is independent of climate conditions and intensity of light.